A Dissertation on

"UTILITY OF SURGICAL APGAR SCORE IN PREDICTING POSTOPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING LAPAROTOMY – A PROSPECTIVE STUDY"

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CERTIFICATE

This is to certify that the dissertation entitled **"UTILITY OF SURGICAL APGAR SCORE IN PREDICTING POST OPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING LAPAROTOMY – A PROSPECTIVE STUDY"** is a bonafide research work of postgraduate M.S. student, **Dr. VIJAYA RAGHAVAN P,** in the Institute of General Surgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai, in partial fulfillment of the requirement for the degree of M.S. in GENERAL SURGERY to be held in APRIL 2017 under my guidance and supervision in 2016.

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DECLARATION

I hereby declare that the dissertation entitled **"UTILITY OF SURGICAL APGAR SCORE IN PREDICTING POSTOPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING LAPAROTOMY – A PROSPECTIVE STUDY"** is a bonafide and genuine research work carried out by **Dr.VIJAYA RAGHAVAN P** under the guidance of **Dr.P.RAGUMANI**, Director and Professor, Institute of General Surgery, Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai.

The Tamil Nadu Dr. M.G.R. Medical University, Chennai shall have the rights to preserve, use, and disseminate this dissertation in printed or electronic format for academic/research purpose.

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ABBREVIATIONS

SAS	–	SURGICAL APGAR SCORE
MMC	–	MADRAS MEDICAL COLEGE
RGGGH	–	RAJIV GANDHI GOVERNMENT GENERAL HOSPITAL
POSSUM	–	PHYSIOLOGY AND OPERATING SEVERITY SCORE FOR THE ENUMERATION OF MORTALITY AND MORBIDITY
MmHg	–	MILLIMETER OF MERCURY
ASA	–	AMERICAN SOCIETY OF ANAESTHESIOLOGY
SRS	–	SURGICAL RISK SCORE
P-POSSUM	–	PORTSMOUTH POSSUM
APACHE	–	ACUTE PHYSIOLOGICAL AND CHRONIC HEALTH EVALUATION
NSQIP	–	NATIONAL SURGICAL QUALITY IMPROVEMENT PROGRAMME
ICU	–	INTENSIVE CARE UNIT
HDU	–	HIGH DEPENDENCY UNIT

INTRODUCTION

INTRODUCTION

The best model to determine the postoperative complications must be simple and easily applicable to the majority of the surgical patients. The complications and their incidence should be precisely defined and estimated. The model should also have low threshold to identify them.

There are many factors that alters the patient's condition during the surgery including extremes in blood pressure (hyper or hypotension), hypothermia, bradycardia / tachycardia and the quantity of blood lost during the surgery. It has been noticed that patients with intraoperative mean arterial pressure less than 70mmHg have an increased risk of complications. Bradycardia and hypotension are also independently linked to poor outcomes in the recovery period. It has also been found that higher wound class and ASA class have a direct proportionate to the postoperative mortality and morbidity. A higher wound class and ASA class have a higher rate of postoperative complications. There is no definitive method available to directly evaluate the performance and safety during a surgery using these variables. Each and every component should be independently and collectively contribute in predicting the outcome for a score to be a clinically useful predictor of postoperative mortality and morbidity.

During the surgery, the surgeon mostly relies on his “gut feeling” rather than a objective assessment to predict the postoperative happenings. The intraoperative management plays an important role in determining the overall outcome of the patient even though there is no quantitative measure of the operative care provided available.

Gawande et al derived a simple surgical outcome score. This score will allow the members of the operating team to collect the information immediately on finishing the surgery, regardless of available resources and technological capacity. This ten point Surgical Apgar Score also known as the SAS score predicts the postoperative mortality and morbidity and can be used in all specialties of surgery. 28 parameters were collected during the surgery and analyzed. Of these 28 parameters, only three intraoperative variables remained independent predictors of major catastrophe following surgery. The three important variables that were derived and formulated into the Surgical Apgar Score are the lowest heart rate, the lowest mean arterial pressure and estimated blood loss during the surgery.

The SAS score provides a easy, quick and a objective mean of estimating and communicating the patient outcome following a surgery, using data that are routinely available even in low resource settings. The score can be very useful in choosing patients at higher- and lower-than-

average likelihood of severe complications post-surgery and may be helpful for guiding interventions to avoid poor outcomes.

The parameters of the score highlights the patient's overall condition. The degree of surgical insult and the efficacy of the surgical team to respond to and control haemodynamic changes during the operation. Blood pressure and heart rate alterations represent both the physiological status of the patient and the adequacy of anaesthetic management. The difficulty of the surgery and the efficacy of the surgeon can be predicted by blood lost during the surgery. These parameters sums up to a score that provides the clinicians with a feedback on the relative success of their surgery and the relative risks for mortality and morbidity.

There are many risk-scoring systems that are currently available for use in surgical patients. But most of these scores are not easy to calculate bedside, requires a lot of data elements that may rely on laboratory data that are not uniformly collected and analyzed. Hence, a majority of these scores are not routinely used in surgical patients. The SAS has been mainly validated in the West and not much of Indian studies are available.

Laparotomy is one of the most common surgical procedure performed at Rajiv Gandhi Government General Hospital and is always associated with significant morbidity and mortality. There has been no

comparative tool to quickly assess and objectively determine the status of the patient using intraoperative physiological parameters. Many a time POSSUM and P-POSSUM scores have been tried in the past but because of their complex nature they have not gained widespread acceptance.

Local studies have mainly used the admission clinical parameters with the outcome of the diagnosis but none of the intraoperative parameters has so far been evaluated for predicting mortality and morbidity in patients who underwent laparotomies.

This study will aid us to find out the efficacy of the SAS in patients who undergo laparotomy in Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai. This study will mainly determine the score ability to predict the major postoperative complications that are common in our set of people. It will also help in making objective decisions with regard to the location of the patients in the immediate postoperative period.

The aim of this study was therefore, is to evaluate the applicability of the Surgical Apgar Score aka SAS in stratifying the post-operative risks in patients undergoing laparotomy at Madras Medical College & Rajiv Gandhi Government General Hospital. This may finally help the local surgical teams with a very simple, easy and a reliable score for stratifying the post-operative risks in this group of patients.

TABLE 1 – SURGICAL APGAR SCORE

	0 points	1 point	2 points	3 points	4 points
Estimated blood loss(ml) α	>1000	601-1000	101-600	≤ 100	-
Lowest Mean Arterial Pressure (mmHg) β,Ω	<40	40-54	55-69	≥70	
Lowest Heart Rate (beats per min) β,Δ	>85	76-85	66-75	56-65	≤55†

Surgical Apgar score = Sum of the points for each category.

† -Occurrence of pathologic bradyarrhythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and asystole also receive 0 pts for lowest heart rate.

A – The estimated blood loss used in the calculation should be the number entered in the official operation record. This is computed by the anaesthetist and confirmed by the surgeon.

B –The heart rate and blood pressure obtained from the anaesthesia record, as values recorded from the time of incision to the time of wound closure.

Ω - Mean arterial pressure is used to calculate the blood pressure score. When the systolic and diastolic blood pressures are recorded without mean arterial pressure, the lowest mean arterial pressure must be calculated by selecting the lowest diastolic pressure and using the formula: mean arterial pressure = diastolic pressure + (systolic pressure– diastolic pressure)/3.

Δ-In cases in which asystole or complete heart block occurs the score for heart rate should be zero.

AIMS AND OBJECTIVES

AIM OF STUDY

The aim of the study is to determine the applicability of the Surgical Apgar Score in post-operative risk stratification for morbidity and mortality during the 30 days post-laparatomy at MMC/RGGGH.

OBJECTIVES OF THE STUDY

1. To determine the proportion of patients undergoing laparatomy who develop major complications during the 30-day post-operative period.
2. To determine a 30-day post-operative mortality of patients undergoing laparatomy.
3. To determine the relationship between the Surgical Apgar Score and the occurrence of major complications and mortality during the 30- day post-operative period.

REVIEW OF LITERATURE

REVIEW OF LITREATURE

Peri-operative risk stratification of mortality and morbidity is important in the provision of health care to ensure appropriate resource allocation and enable informed decision making by the recipient. Proper communication and knowledge about the degree of illness can be predicted by risk-scoring systems which provides objectivity and mortality. Scores that include subjective parameters will allow the doctors to use their experience and understanding of the situation to an individual but are not reproducible. Scores like American Society of Anaesthesiologists (ASA) score and Surgical Risk Scale (SRS) utilize subjective measures and have been condemned for this. Most systems have demerits relating to collecting variables, generalization in different patient categories and calculating predicted mortality and applicability are present in more systems.

Reduction of postoperative mortality and morbidity marks a benchmark for determining the quality of health care provided in a health institution. The main aim of both the hospital administration and the surgical team is to provide surgical services with the least major postoperative complications, thereby keeping the cost of healthcare to the patient and the hospital to the minimum. Most of the major postoperative complications are linked to perioperative risk factors in the patient.

For the hospitals to provide quality surgical care, installation and commission of all available resources is required to enable the most deserving patient to receive the optimum care. To satisfy this it is very important to find out the potential risks of developing complication after surgery.

Patients with postoperative complications had a higher predicted probability of readmission and the cost of the readmission was greater than patients without a complication as demonstrated by Lawson et al., using the Medicare system. On reducing the postoperative complications, one could estimate a cost reduction of §620.3 million per year.

In a tertiary hospital, hospital stay was increased by 114% and hospital cost by 78% if patient developed postopertative complications as demonstrated by Khan et al.

If complications are predicted earlier, it can help in predicting readmissions, stepping up or stepping down the level of care depending on the probability of a complication occurring. It also helps in accumulating medical personnel in a particular shift.

Hence, proper stratification and risk scoring is essential to aid in proper clinical practice.

All patients undergoing surgery are assessed at various stations from admission to discharge and follow up in the outpatient clinics. This can be generally categorized into three categories:

1. Preoperative assessment; where intervention planning and inbuilt physiological and acquired pathological co-morbidity assessment is carried out.
2. Perioperative assessment; where patient's most suitable setting for further care is determined depending on the perioperative risk stratification (i.e. admission into general ward, Intensive Care Unit / High Dependency Unit or day care setup).
3. Postoperative assessment; where postoperative management on a surgical patient is altered by the scores calculated from the intraoperative variables.

Postoperative morbidity and mortality are generally linked with three major risk factors:

1. Patient comorbidities
2. Nature of surgical procedure and
3. Anaesthetic risks

The American Society of Anaesthesiologists (ASA) score is used by anaesthetists determine a surgical patient's comorbidity preoperatively.

Both 30-day as well as 48-day postoperative day mortality is associated with a higher ASA score. Almost 35% of ASA grade V patients expire within 48 hour of surgery and nearly 50% of these patients die within the next 30 days.

In the management of General Surgical patients, no validated approved comparative score was available till 2008 when the Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) and the Portsmouth-POSSUM (P-POSSUM) scoring systems were assessed in Indian patients undergoing elective laparotomy and it was concluded that the P-POSSUM score was more precise in predicating the overall mortality.

The existing scores to predict mortality and morbidity such as the Acute Physiological and Chronic Health Evaluation (APACHE) and Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity (POSSUM) and there derivations are limited by their complexity, discouraging use in low resource settings. The similar scenario also applies to the National Surgical Quality Improvement Programme (NSIQIP) database used in the West. The need of numerous data that are not uniformly collected and existence of interdisciplinary approach disagreement on their interpretation also makes these scores far from using them in their regular practice.

APACHE II SCORING SYSTEM

APACHE II									
	+ 4	+ 3	+ 2	+ 1		+ 1	+ 2	+ 3	+ 4
Temperature	≥ 41	39-40.9		38.5-38.9	**36-38.4**	34-35.9	32-33.9	30-31.9	≤ 29.9
MAP	≥ 160	130-159	110-129		**70-109**		50-69		≤ 49
HR	≥ 180	140-179	110-139		**70-109**		55-69	40-54	≤ 39
RR	≥ 50	35-49		25-34	**12-24**	10-11	6-9		≤ 5
Oxygenation[1]	≥ 500	350-499	200-349		**< 200** P_{aO2} **> 70**	61-70		55-60	< 55
pH	≥ 7.7	7.6-7.69		7.5-7.59	**7.33-7.49**		7.25-7.32	7.15-7.24	< 7.15
Na^+	≥ 180	160-179	155-159	150-154	**130-149**		120-129	111-119	≤ 110
K^+	≥ 7	6.6-6.9		5.5-5.9	**3.5-5.4**	3-3.4	2.5-2.9		< 2.5
Creat	≥								
Hct	≥ 60		50-59.9	46-49.9	**30-45.9**		20-29.9		< 20
WCC	≥ 40		20-39.9	15-19.9	**3-14.9**		1-2.9		< 1
15-GCS									

[1] $F_IO_2 > 0.5$ record $\delta A\text{-}aO_2$ $F_IO_2 < 0.5$ record P_{aO2}

TABLE 2 – APACHE SCORING SYSTEM

POSSUM SCORING SYSTEM

Physiologic score	Operative severity score
Age*	Operative severity*
Cardiac signs/chest radiograph*	Multiple procedures
Respiratory history/chest radiograph	Total blood loss (mL)
Blood pressure, systolic (mmHg)*	Peritoneal soiling*
Pulse (beats/min)*	Presence of malignancy*
Glasgow Coma Scale	Mode of surgery*
Hemoglobin (g/100 mL)*	
White cell count ($\times 10^{12}$/L)	
Urea (mmol/L)*	
Sodium (mmol/L)	
Potassium (mmol/L)	
Electrocardiogram	

TABLE 3 – FACTORS IN POSSUM SCORE

POSSUM scoring system is based on physiological factors such as age, cardiac signs, respiratory signs, blood pressure, pulse rate, Glasgow coma scale, haemoglobin, total leukocyte count, urea, potassium and ECG findings & operative factors such as number of procedures, amount of blood loss, amount of peritoneal soiling, presence or absence of malignancy and the mode of surgery.

POSSUM SCORING SYSTEM

Parameters	(a) Physiological score			
	1	2	4	8
Age	≤60	61-70	≥70	
Cardiac signs	No failure	Diuretic, digoxin, anti-anginal or hypertensive therapy	Peripheral oedema or warfarin therapy	Raised central venous pressure or cardiomegaly
Respiratory signs*	No dyspnoea	Dyspnoea on exertion, mild obstructive airway disease	Limiting dyspnoea (one flight) or moderate obstructive airway disease	Dyspnoea at rest (rate ≥30/min) fibrosis or consolidation
Systolic blood pressure (mmHg)	110-130	131-170 100-109	≥171 90-99	≤89
Pulse (rate/minute)	50-80	81-100 40-49	101-120	≥121≤39
Glasgow coma scale*	15	12-14	9-11	≤8
Haemoglobin (g/dl)	13-16	11.5-12.9 16.1-17.0	10.0-11.4	≤9.9≥18.1
White cell count* (10^3 cells/L)	4-10	10.1-20 3.1-4.0	≥20.1≤3.0	
Urea (mmol/L)	≤7.5	7.6-10	10.1-15.0	≥15.1
Sodium* (mmol/L)	≥136	131-135	126-130	≤125
Potassium* (mmol/L)	3.5-5.5	3.2-3.4 5.1-5.3	2.9-3.1 5.4-5.9	≥2.8≥6.0
Electrocardiogram*	Normal		Atrial fibrillation (rate 60-90)	Any abnormal rhythm or ≥5 ectopics/minute or Q waves or ST/T wave changes
	(b) Operativescore			
Operative severity	Minor	Moderate	Major	Major+
Multiple procedures*	1		2	>2
Total blood loss* (ml)	≤100	101-500	501-999	≥1000
Peritoneal soiling	None	Minor (serous fluid)	Local pus	Free bowel content
Malignancy	None	Minor (serous fluid)	Nodal metastasis	Distant metastasis
Mode of surgery	Elective		Urgent	Emergency

*Parameters which are not included in CR-POSSUM. P-POSSUM=Portsmouth-POSSUM; CR-POSSUM=Colorectal-POSSUM

TABLE 4 – POSSUM SCORING SYSTEM

NATIONAL SURGICAL QUALITY IMPROVEMENT PROGRAMME

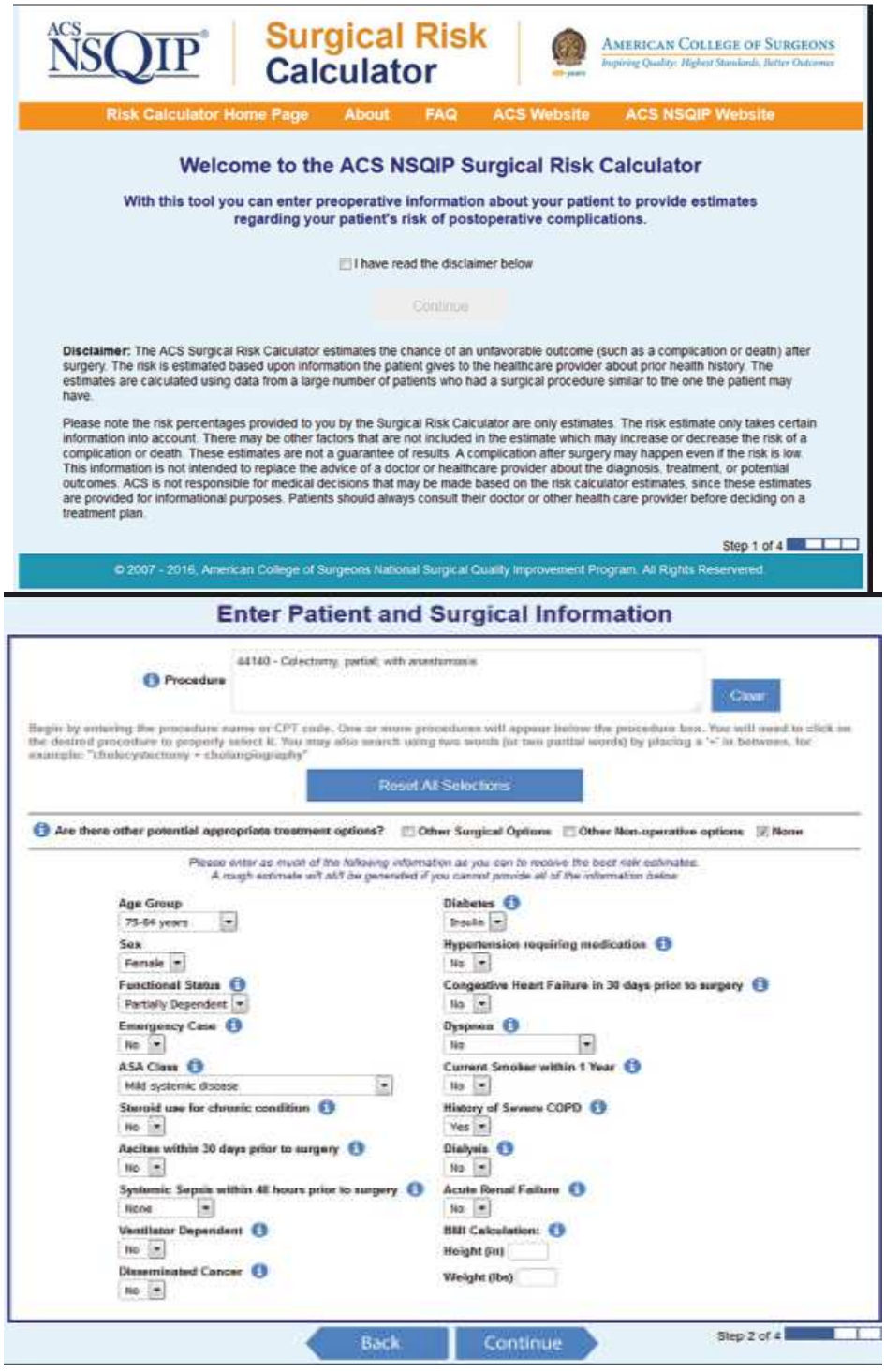


FIGURE 1 – STEP 1 & 2 OF NSQIP SCORE CALCULATION

NATIONAL SURGICAL QUALITY IMPROVEMENT PROGRAMME

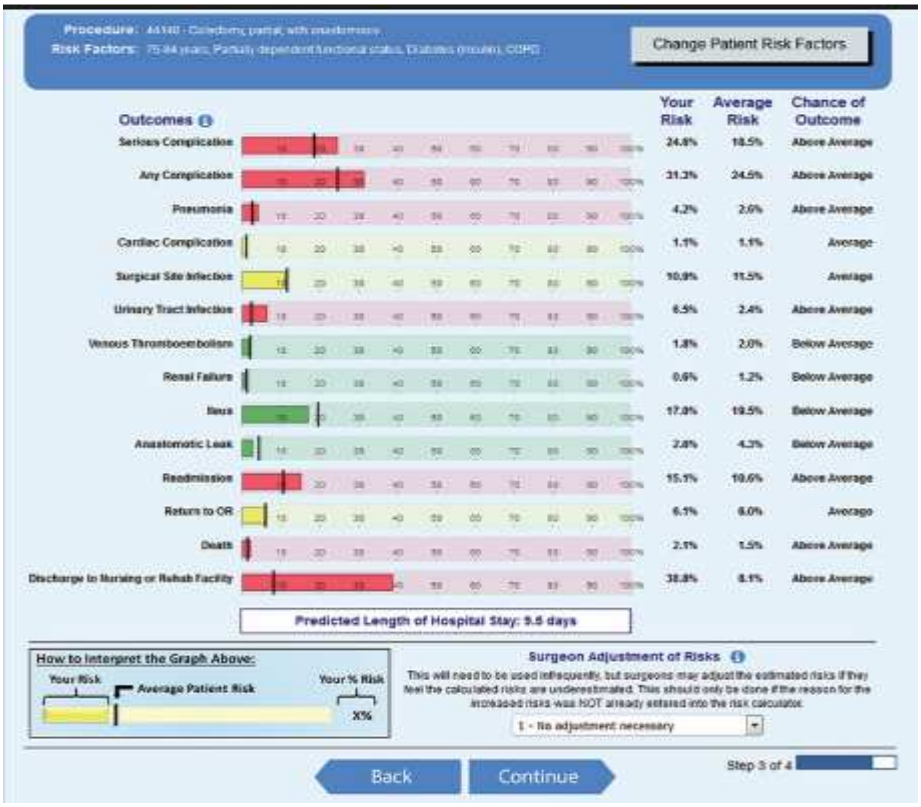


FIGURE 2 – STEP 1 & 2 OF NSQIP SCORE CALCULATION

AMERICAN SOCIETY OF ANAESTHESIOLOGISTS SCORE

ASA Classification		Examples:
ASA I	A normal healthy patient	Healthy; no smoking, no or very minimal drinking.
ASA II	A patient with mild systemic disease	Smoker; more than minimal drinking; pregnancy; obesity; well controlled diabetes, well controlled hypertension; mild lung disease.
ASA III	A patient with severe systemic disease, not incapacitating	Diabetes, poorly controlled hypertension; distant history of MI, CVA, TIA, cardiac stent; COPD, ESRD; dialysis; active hepatitis; implanted pacemaker; ejection fraction below 40%; congenital metabolic abnormalities.
ASA IV	A patient with severe systemic disease that is a constant threat to life	Recent history of MI, CVA, TIA, cardiac stent; Ongoing cardiac ischemia or severe valve dysfunction; implanted ICD; ejection fraction below 25%.
ASA V	A moribund patient who is not expected to survive without the operation	Ruptured abdominal or thoracic aneurism; intracranial bleed with mass effect; ischemic bowel in the face of significant cardiac pathology..
ASA VI	A patient who has already been declared brain-dead and whose organs are being removed for transplant.	
The addition of an 'E' indicates emergency surgery.		

FIGURE 3: ASA SCORING SYSTEM

ASA PHYSICAL STATUS CLASSIFICATION

ASA physical status	I	II	III	IV	V	VI
Definition	"Healthy"	"Mild systemic disease"	"Severe systemic disease but not incapacitating"	"Incapacitating disease"	"Dying"	"Declared brain death"
Age	> 3 months to < 65 years	≤ 3 months or ≥ 65 to 84 years	≤ 1 month preterm NB or ≥ 85 years			
Functional capacity; walk up 1 flight of stair or 200 m. on the level	Complete without distress	Rest at completion because of distress	Stop en route because of distress	Unable to do		
Medical status	No organic, physiologic, or psychiatric disturbance	Single/multiple systemic disease(s) with good control No functional limitations or vital organ involvement	Poorly controlled systemic disease(s) Some functional limitations No immediate life threatening condition	Poorly controlled systemic disease(s) Significant functional limitation Constant potential threat to life	End stage disease(s) and not expected to survive within 24 hours	Clinically dead patients awaiting organ harvest
Mortality rate (%)	0.06 – 0.08	0.27 – 0.4	1.8 – 4.3	7.8 – 23	9.4 – 51	
Emergency status	In addition to indicating ASA physical status, any patient undergoing an emergency operation is indicated by the suffix "E", e.g., ASA III E					

SURGICAL APGAR SCORE

Virgin Apgar devised a scoring system for determining the condition of newborns using the basic physiological parameters in the year 1953. Its simple nature and usefulness in predicating the performance of newborn after delivery led to its overall worldwide acceptance.

The same principle was used by Gawande et al and they came up with an intraoperative scoring system known as the Surgical Apgar Score. It is based on three easily measured physiological criteria; estimated blood loss, lowest intraoperative heart rate and the lowest intraoperative mean arterial pressure. Preoperative, intraoperative and postoperative data was collected in three cohorts of patients, starting from a single type of procedure to a broader category of patients in general and vascular surgery, following which a score was devised. National Surgical Quality Improvement Program's (NSQIP) outcome database was used and 28 intraoperative variables from the anesthetic data for each patient were analyzed. 2 preoperative and 9 intra-operative variables were associated wit major complications and death within 30 days of surgery. From these 11 parameters, the lowest heart rate, estimated blood loss and the lowest Mean Arterial Pressure were found to be independent predictors of the post-surgical outcomes.

The score calculated from these parameters composes a predictive model for classifying patients at risk of major postoperative complications in general and vascular surgical procedures. Lower SAS score is associated with higher chances of developing complications. Major complications are seen in 58.6% of patients with score of less than 4, while only 3.6% of patients with a score of 9 or 10 developed complications.

The performance of the heart and the amount of blood loss in surgery plays an important role in determining the postoperative course of a patient. The collective importance of heart rate, blood pressure and blood loss and their contribution towards intraoperative performance can be easily recognized by the SAS.

Details obtained from this scoring system can used to plan effective postoperative approach in patients with a low score and also guide clinicians in taking preventive measures such as optimizing blood pressure, heart rate and restoring intravascular volume. The surgeon, on getting an immediate score after surgery, is able to classify the patients who need severe postoperative monitoring from those who are more likely to have an uneventful course. This suggests that the SAS may be highly useful in surgical patients who are prone to a high rate of postoperative morbidity and mortality. It also functions as a mode of

communication between surgeons, residents and nursing staff about a patient's postoperative status and assist in decision making. This includes decisions like when to discharge the patient after surgery, admission to ICU, frequency of postoperative visits, follow up at outpatient clinics and having a high index of suspicion to pick up a complication at an early stage.

From the time Gawande introduced this scoring system, it has been widely used in different fields of surgery like general surgery, vascular surgery, gynaecology, urology and neurosurgery with promising predictive values. There has been some critique on calculation of estimated blood loss and its subjectiveness. However studies done to evaluate the score, categorizes blood loss in categories of 0-100 ml, 101-600 ml, 600-1000 ml, >1000 ml which are easily within the observer's range of precision. Blood loss can also be calculated using a mathematical formula which uses a patient's hematological parameters and exclude biases. There is also a dispute over the influence of anaesthetic manipulations and drugs on intra-operative haemodynamic parameters which comprise the score. However, evidences show that alteration in blood pressure and heart rate whether caused by the patient's pathology or influenced by the anaesthetist during surgery will have a final impact on the outcomes of surgery.

The score in all previous studies has been used across all groups of patients with different preoperative comorbidities. The score has been proven to be effective as measure of the postoperative condition of the patient regardless of the complexity of the preoperative risk stratification.

While this SAS score has been widely approved in most of the developed countries, more global studies in various populations are required before the SAS score becomes popular and approved as APACHE and P-POSSUM.

The Surgical Apgar Score is extensively used in general surgery and vascular surgery fields of surgical medicine. A study was done in developed country where the SAS score has been validated where morbidity, mortality, ICU/HDU stay and hospital stay were found to have a strong correlation with the Surgical Apgar Score. It was a retrospective study and the author had suggested a prospective study to verify the findings in other institutions.

In another study to evaluate the Surgical Apgar Score in all surgical specialities including 7,589 neurosurgery patients concluded that it carries procrastination in neurosurgical patients, there exists variations among other specialities.

TABLE 5 : THE SURGICAL APGAR SCORE – RISK STRATIFICATION

	0 point	1 point	2 point	3 point	4 point
Estimated blood loss(ml)	**>1000**	**601-100(**	**101-60(**	**≤ 100**	**-**
Lowest Mean Arterial Pressure(mn	**<40**	**40-54**	**55-69**	**≥70**	
Lowest Heart Rate(beats per min)	**>85**	**76-85**	**66-75**	**56-65**	**≤55**

Surgical Apgar score = Sum of the points for each category.

Interpretation of score:	Risk group	Surgical Apgar Sore
	High	0 to 4
	Medium	5 to 7
	Low	8 to 10

In order to find out the feasibility of the Surgical Apgar Score, the World Health organization conducted a pilot study in several areas worldwide. Patients having a score of less than 5 had a three times greater risk for a postoperative complication whereas patients with scores of 9 or 10 had only one third the risk of patients who had a score of 7. This study has proved that the score as a simple, reliable measure regardless of the setting.

Criticisms of this scoring system are that blood loss during surgery can be subjective although the wide categories utilized allow for reasonably accurate estimation.

Among the currently available risk-scoring systems available for surgical patients, the Surgical Apgar Score stands out as one hold promise for routine application in low resource settings.

In this SAS, various points are given for the following parameters. With estimated blood loss kept as a parameter, 0 point is given if the blood loss is more than 1000ml, 1 point if the intraoperative blood loss is between 601ml and 1000ml, 2 points if the blood loss is between 101ml and 600ml and 3 points if the blood is equal to or less than 100ml.

If the lowest mean arterial pressure measured in mm of hg is less than 40, a point of 0 is given. If it is between 40 and 54mmHg, 1 point is given. If the mean arterial pressure is between 55 and 69mmHg, 2 points are given. If the MAP is more than 70mmHg, then 3 points are given.

If the lowest heart rate is greater than 85 beats per second, a point of 0 is given. If it is between 76 and 85 beats per second, then 1 point is given. If the lowest heart rate is between 66 and 75 beats per second, 2 points are given. If it is between 56 and 65 beats per second, 3 points are given and if the lowest heart rate is less than 55 beats per second, a total point of 4 is given.

The Surgical Apgar Score is calculated by summing up all the points in each category during the course of a procedure.

Occurrence of pathologic bradyarrythmia, including sinus arrest, atrioventricular block or dissociation, junctional or ventricular escape rhythms, and asystole also receives 0 points for lowest heart rate.

The estimated blood loss used in the calculation should be the number entered in the official operation record. This is computed by the anaesthetist and confirmed by the surgeon.

The heart rate and blood pressure obtained from the anaesthesia record, as values recorded from the time of incision to the time of wound closure.

Vital multiparameter monitors gives us time to time recording of heart rate, blood pressure, saturation and respiratory rate.

FIGURE 4: MULTIPARAMETER VITAL MONITOR

New technology has been introduced by Gauss Surgical in which the ipad's camera takes the photo of the blood soaked gauze or pad, sends it to a remote server which processes the image and gives the estimated blood loss using the company's custom algorithm.

FIGURE 5: NEW TECHNOLOGY TO ESTIMATE BLOOD LOSS

When the systolic and diastolic blood pressures are recorded without mean arterial pressure, the lowest mean arterial blood pressure must be calculated using the formula: mean arterial pressure = diastolic pressure + (systolic pressure – diastolic pressure)/3

In patients in which asystole or complete heart block occurs the score for heart rate should be zero.

LAPAROTOMY

Any procedure which gains entry into the abdominal cavity through a large incision is called laparotomy. Earlier it was known as celiotomy. Ephiram McDowell in 1809 performed the first successful laparotomy in Danville, Kentucky.

It is derived from the Greek word “lapara” meaning “flank” and the suffix “-tomy” arising from the Greek word “toun” which means “ a (surgical) cut”. Laparotomy are of various types.

In exploratory laparotomy also known as diagnostic laparotomy, the nature of the disease is not known, and laparotomy is deemed as the best procedure for finding out the cause. If a cause has been identified such as a colon cancer and a laparotomy is required for its therapy, it is known as therapeutic laparotomy.

Exploratory laparotomy is considered a stand-alone surgical operation usually. When a specific operation is already planned, laparotomy is considered merely the first step of the procedure.

Laparotomy may give access to any abdominal organ or space and is the first step in any major diagnostic or therapeutic surgical procedures of these organs, which include: the digestive tract comprising of the stomach, duodenum, jejunum and the colon; the liver, pancreas,

gallbladder, and spleen; the urinary bladder, the male prostate, the female reproductive organs such as the uterus and the ovaries and the retroperitoneum which includes the kidneys, the aorta, the inferior vena cava and the abdominal lymph nodes.

The most common incision for laparotomy is the midline incision which is a vertical incision extending from the Xiphisternum upto Pubic Symphysis following the linea alba. These incisions are most commonly used in diagnostic laparotomy as they allow wide access to most of the abdominal cavity. Upper midline incision extends from the Xiphoid process to the umbilicus and the lower midline incision extends from the umbilicus to the Symhysis pubis. Other common laparotomy incisions include Kocher (right subcostal) incision, Rockey-Davis muscle splitting incision, Pfannensteil incision, Marylad incision, Lumbotomy incision and Cherney incision.

VERTICAL LAPAROTOMY INCISIONS:

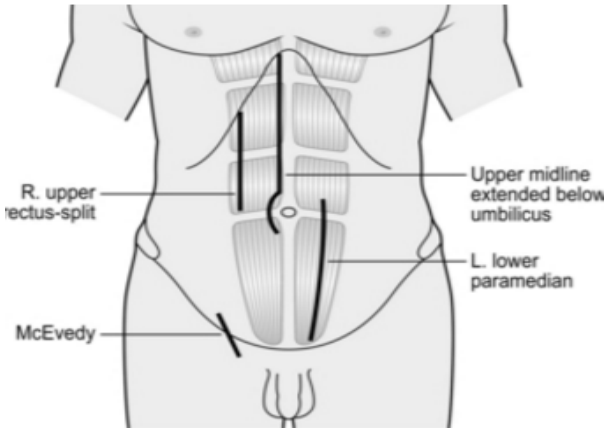


FIGURE 6 – VERTICAL LAPAROTOMY INCISIONS

HORIZONTAL & OBLIQUE LAPAROTOMY INCISIONS:

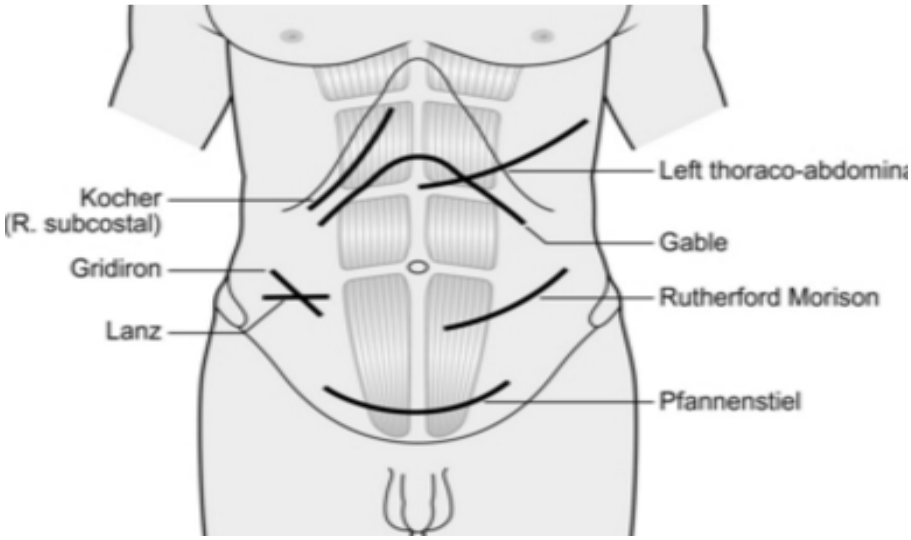


FIGURE 7 – HORIZONTAL & OBLIQUE LAPAROTOMY INCISIONS

Explorative laparotomy is the type of laparotomy in which there is no definitive preoperative diagnosis and there is always a need for this surgery to find out the diagnosis. Therapeutic laparotomy is one in which there is a definitive diagnosis prior to the surgery and the laparotomy surgery is done to cure the patient of the disease.

In all cases of explorative laparotomy, abdomen should be divided into two compartments namely: the supramesocolic and the inframesocolic compartment. In the supramesocolic compartment, one should look into the pathology of liver, stomach and spleen. In the inframesocolic compartment, one should thoroughly screen for the pathology in the small bowel, large bowel, female reproductive organs

and the urinary bladder. In the inframesocolic exploration, the transverse mesocolon is moved cranially towards the head end whereas in supramesocolic exploration, the transverse mesocolon is moved caudally.

There are various maneuvers for the exploration of the retroperitoneum. Kocher's maneuver helps in the exploration of structures behind the deuodenum and pancreas. Abdominal aorta, Inferior vena cava, Superior mesenteric artery, and the right renal vessels can be visualized by Cattle Braasch maneuver. Abdominal aorta and the left renal veins can be studied by Mattox maneuver.

Peritoneal toileting with the concomitant use of systemic antibiotics is no more warranted. Studies have shown that there is no added advantage of peritoneal lavage when systemic antibiotics are also used. Drainage tube usage has become limited. It should be used only when in doubt. In other scenarios, when there is no doubt, drains must be avoided since it is impossible for any drainage tube to effectively drain the entire free peritoneal cavity.

With the discovery of state of art investigations, the number of explorative laparotomies performed has been drastically reduced. Explorative laparotomies are now performed only in emergency setting. Whenever possible, it is always better to come to a provisional diagnosis

before proceeding on with laparotomy. This gives the surgeon a better focus during the surgery.

Therapeutic laparotomy is just a common name for all laparotomies with the diagnosis known in hand. It can be called by different names depending on the organ being operated upon. It can be a cholecystectomy or a splenectomy or a whipples procedure or a resection and anastamosis or an ostomy and so on and so forth. It has been documented in previous literatures that with the diagnosis in hand, one can plan the surgery prior leading to less duration of surgery. Hence, therapeutic laparatomy is always associated with a lesser mortality and morbidity when compared with explorative laparotomy.

POST-OPERATIVE COMPLICATIONS:

Major postoperative complications according to the definitions used by the American College of Surgeon's National Surgical Quality Improvement Program are the following :

Acute renal failure, bleeding requiring 4 units of red cell transfusion within 72 hours after surgery, cardiac arrest requiring cardiopulmonary resuscitation, coma for 24 hours, deep venous thrombosis, myocardial infarction, unplanned intubation, ventilator use for 48 hours, pneumonia, pulmonary embolism, stroke, major wound

disruption, surgical site infection, sepsis, septic shock syndrome, systemic inflammatory response syndrome, unplanned return to the operating room, and vascular graft failure.

Copeland et al had studied a number of patients and opened a new branch towards the list of postoperative comorbidity. According to them, they have classified postoperative morbidity under 14 headings namely superficial and deep wound infections, wound haemorrhage – superficial, deep wound haemorrhage, chest infection, pyrexia of unknown origin, septicemia, wound dehiscence, deep vein thrombosis, impaired renal function, hypotension, respiratory failure and anastamotic leakage.

We in our study have taken the factors described by Copeland et al as a criteria for assessing the postoperative complications.

DEFINITIONS OF MORBIDITY (COPELAND ET AL):

1. **Wound haemorrhage:** local hematoma requiring evacuation.
2. **Deep haemorrhage:** post-operative bleeding requiring re-exploration or transfusion of 4 units of blood or more.
3. **Chest infection:** production of purulent sputum with or without chest radiograph changes or pyrexia.
4. **Wound infection:** wound cellulitis or discharge of purulent exudates.

5. **Deep infection:** presence of intra-abdominal collection confirmed clinically or by imaging Urinary infection: presence of positive urine cultures
6. **Septicaemia:** presence of positive blood cultures with clinical signs and symptoms
7. **Pyrexia of unknown origin:** any temperature above 37.5 0C for more than 24 hours occurring after the original fever following surgery has settled, for which no obvious cause could be found
8. **Wound dehiscence:** superficial or deep wound breakdown
9. **Deep venous thrombosis and pulmonary embolus:** confirmed by Doppler study
10. **Cardiac failure:** symptoms or signs of left ventricular or congestive cardiac failure
11. **Impaired renal function:** arbitrarily defined as an increase in blood urea of more than 5 mmol/L above pre-operative levels.
12. **Hypotension:** a fall of systolic blood pressure to less than 90 mmHg for more than 2 hours
13. **Respiratory failure:** respiratory difficulty requiring emergency ventilation and blood gas analysis findings.

14**. Anastomotic leakage:** discharge of bowel content via a drain, wound or abnormal orifice

All these are important postoperative complications that one should diagnose at an early stage. These complications are life-threatening and one should carefully look at early signs of diagnosing them. Missing even one of these signs would lead to the death of the patient. This would add up the postoperative mortality of the patient.

Hence, this Surgical Apgar Score is very important in risk stratification of the patient. People stratified as high risk would necessitate daily careful observation and monitoring so that these diagnosis could be picked up at an early stage and treated accordingly. Furthermore, necessary precautions should be taken in these patients in high risk group so that these postoperative complications could be avoided. These would decrease the postoperative mortality and morbidity intoto.

SUPERFICIAL WOUND INFECTION **DEEP WOUND INFECTION**

WOUND DEHISCENCE **DEEP VEIN THROMBOSIS**

FIGURE 8 – WOUND COMPLICATIONS

JUSTIFICATION FOR THE STUDY

Laparotomy is one of the most common surgery performed in both elective and emergency theatres of Rajiv Gandhi Government General Hospital, Chennai. Complications in these patients during their recovery period are not uncommon. The Surgical Apgar Score is a simple and reliable tool which can be easily calculated by the surgeon when writing his operation notes. The parameters are easy to obtain without additional cost to the hospital and the patient.

The Surgical Apgar Score has been mainly validated in resource rich western settings and no published studies are available in the Indian population especially in Tamil Nadu population. The SAS has been proven efficient in predicting major postoperative complications in the foreign nations but there has not been a local study to evaluate its efficacy in patients undergoing major abdominal surgeries especially laparotomies.

There has not been any comparative risk evaluating system using intra-operative parameters which has been actively used for patients undergoing laparotomy in this hospital.

Establishing its applicability would provide a simple, cost-effective tool for identifying patients requiring close post-operative monitoring in our resource-limited setting.

MATERIALS AND METHODS

METHODS AND MATERIALS

STUDY AREA:

The study was conducted at Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai. This is one of the largest referral hospital in country being the largest referral hospital in the state of Tamilnadu. It accommodates approximately 10 lakh inpatients a year. It is more than 3000 bedded inpatient public health facility. The study is conducted in the hospital's surgical intensive care unit, male and female postoperative wards, male and female general wards and elective and emergency theatres of the general surgery department in the hospital.

Patients undergoing laparotomy at MMC & RGGGH are managed by a tier of doctors from anaesthetic technicians, medical officer interns, medical officers, postgraduates in general surgery and aneasthesiology and their consultants. Interns and postgraduates in general surgery provided the pre and postoperative care and participate in general surgical procedures whenever indicated. Anaesthesiologists apart from providing anaesthesia during surgery, extended their care in the intensive care unit.

The institution has a capacity to undertake major surgical procedures on the round the clock basis.

STUDY POPULATION:

The target population were patients undergoing laparotomy admitted to the general surgical wards, intensive care unit and postoperative wards who met the eligibility criteria. Selection of patients was from the point first seen at Rajiv Gandhi Government General Hospital, Chennai.

Those admitted for emergency surgery were selected from the accident and emergency department. Those to undergo elective surgery were recruited in the respective general surgery wards prior to their surgery.

STUDY DESIGN:

This was a hospital based, single centre prospective observational study carried out from March 2016 to September 2016.

INCLUSION CRITERIA:

- All patients above 13 years of age, scheduled for emergency or elective laparotomy at Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai.

EXCLUSION CRITERIA:

- Patients undergoing concurrent major procedures on other body regions during or within 30 days of the laparatomy under study
- Patients with established metastatic and unresectable tumours
- Patients undergoing mini-laparatomy and laparoscopic procedures

STUDY ENDPOINT:

- Patients were followed upto the thirtieth post-operative day after laparotomy.
- Patients discharged before thirty days were followed up at outpatient clinic with assigned dates.

SAMPLING METHOD:

Using non-probability convenience sampling all patients 13 years and above admitted to Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai and for whom laparotomy was scheduled and who met all inclusion and none of the exclusion criteria were recruited until the desired sample size was reached.

SAMPLE SIZE:

Using the formula:

$$N = z^2 \times \frac{p(1-p)}{d^2}$$

Where z : score at 95% confidence interval (1.96)

p : 30 day mortality in laparotomy patients at MMC&RGGGH (4.8%)

d : margin of error (0.05%)

Thus, $n = 1.96^2 \times \frac{0.048 \times 0.952}{0.05^2} = 70.21$

We doubled this figure to account for the effect of clustering anf allow of generalization of results.

With an adjustment of 10% to account for possible losses to follow up, the final figure was set to 154 patients.

DATA COLLECTION:

The primary researcher and a trained assistant recorded the required variables in the data collecting sheet. Data was collected after the surgery (within 24 hours) in the operating theatre, recovery area,

ICU/HDU or in the ward admitted. Anaesthetic notes were used to collect blood pressure, heart rate parameters during the surgery. Blood pressure and heart rate were monitored every fifteen minutes from induction to the reversal of general anesthesia. MAP was calculated by using a formula [diastolic pressure + (systolic pressure – diastolic pressure)/3].

Pre- and Post-operative haematocrit and haemoglobin levels to calculate blood loss was obtained from patient's pre and post surgery full haemogram results. Postoperative follow up rounds and notes both as inpatient and outpatient for the next thirty days after surgery was used to determine the occurrence of any major postoperative complications.

Data was collected using a standard questionnaire administered by the principal researcher and a trained assistant. The collected data was entered into computer and spreadsheets were created. Once data entry was complete, the principal researcher compared the entered data with the hard copy forms to check for errors, inconsistencies, missing entries and duplicate entries to ensure high quality data and make it fool-proof.

Personal identifying information like the patients telephone number which might be needed to remind patients on their due outpatient visits during the study period were coded separately and known only to the investigators. Reference number was used instead of patient's inpatient file number for follow up purposes.

The ‘trained assistant’ was a medical doctor with a minimum qualification of bachelor’s degree in medicine. He/She as familiarized with the study protocol and trained by the principle investigator on how tocollect data from anaesthetic notes., pre and postoperative laboratory results and patients follow up notes from the case sheet. He/She was also shown how to enter the data in the data collection sheet and calculate the Surgical Apgar Score.

Data collected included:

1. Age

2. Sex

3. Nature of operation-emergency vs. elective procedure

4. Diagnosis

5. Duration of procedure in minutes

6. SAS derived from estimated blood loss, lowest recorded mean arterial pressure and lowest recorded pulse rate. The anaesthetist and surgeon determined the estimated blood loss from the number of blood soaked gauze and measurement of the volume of sucked blood intra-operatively.

7. The occurrence of major complications and mortality within 30 days postoperatively was based on follow-up data in admitting ward and surgical outpatient clinic notes. Major complications definitions was according to Copeland et al.

Patients were subsequently grouped into three categories based on their SAS for purposes of risk stratification. Thus;

Risk group	**Surgical Apgar Sore**
High	0 to 4
Medium	5 to 7
Low	8 to 10

Blood loss was calculated using a mathematical formula:

Blood loss = {EBV x (H(i) – H(f))/(Hct(i) – Hct(f))/2} + (500 x T (u))

Where: 1. Estimated blood loss (EBV) is assumed to be $70cm^3/kg$

2. H(i) and H(f) represent pre and post operative haemoglobin

3. Hct(i) and Hct(f) represents pre and postoperative haematocrit

4. T (u) is the sum of whole blood, packed red blood cells, and cell saver units transfused

DATA MANAGEMENT AND ANALYSIS

Data collected was entered and analyzed with the help of statistician and statistic software. P value was generated using t test for means, Chi square (x^2) for comparison of proportions, analysis of variance (ANOVA) and where applicable Fischer's exact test. Value of $p<0.05$ was considered significant.

All raw data is stored in electronic form in a hard drive lying secured with the principle investigator. Access to this data in future by any interested party for the purpose of research or policy making will be after an official permission by the Ethics and Research Committee of Madras Medical College & Rajiv Gandhi Government General Hospital, Chennai.

ETHICAL CONSIDERATIONS

Approval to conduct the study was sought from the Institute of General Surgery, MMC&RGGGH and the institute's Ethics and Research Committee. The committee reviewed the study protocol and granted approval prior to the commencement of the study.

All patients recruited to take part in the study signed an informed consent administered by the principal researcher. All the data was collected confidentially and carefully handled by us.

Patients, Next of the kin or guardians received a briefing on the study title, its objectives and its rationale. There after an informed consent was obtained from the patient. In the event that the patient was found not to be competent to give an informed consent, consent was obtained from the next of kin. For patients under 18 years of age informed consent was obtained from their parents or guardians.

The participant or next of the kin were informed that participations is voluntary and they could withdraw from the study at any point without provision of services from the hospital being interrupted. Patients were not coerced to participate if they were unwilling. Non-participation did not affect patient care. Confidentiality and privacy was observed.

OBSERVATIONS AND RESULTS

RESULTS

One hundred and fifty four patients who matched with the inclusion criteria were adopted in the study after taking due consent from the patients. Of the 154 patients, two patients did not turn up to the hospital during the regular weekly periodic follow-up. This left us with a total of 152 patients. These 152 patients were available to monitor the outcome.

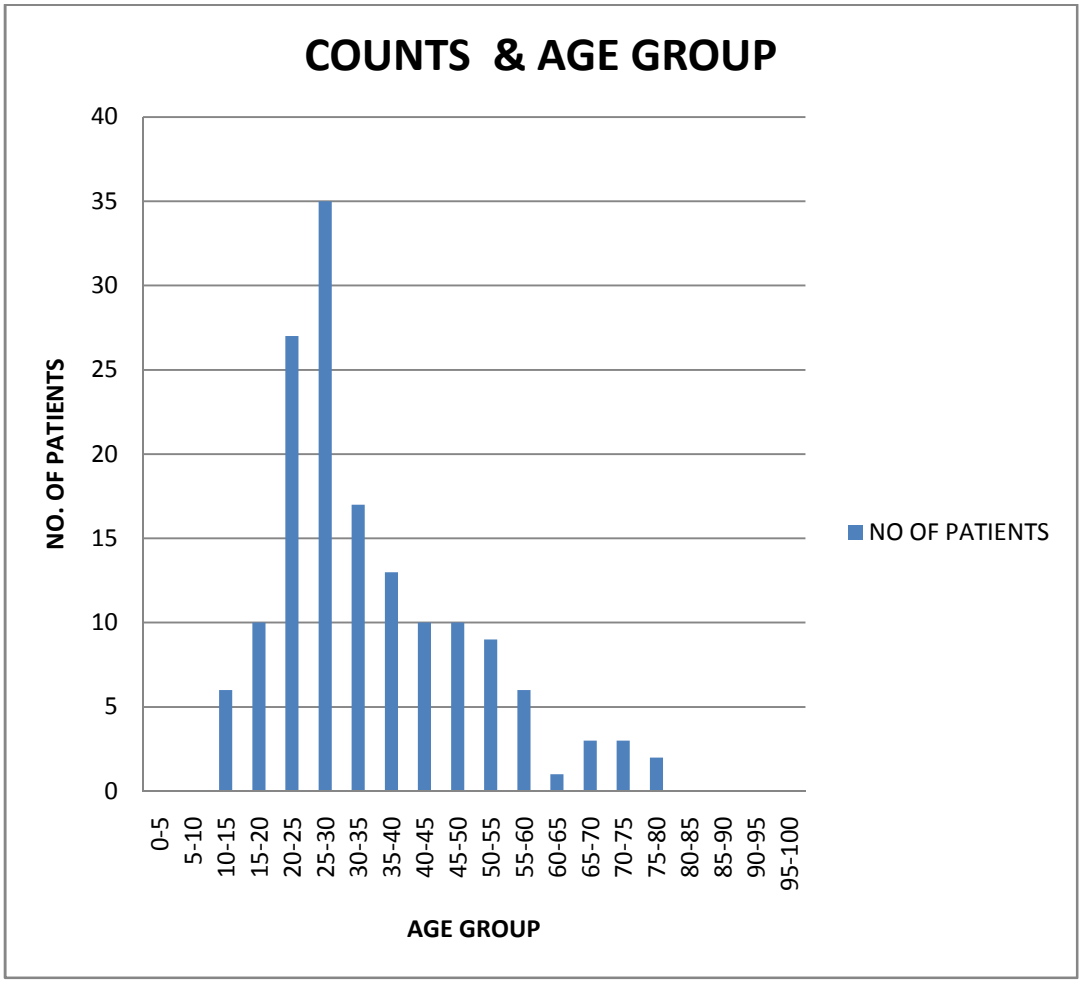
All the patients taken up for the study were between the age group of 14 and 80 years. The median of these age groups was 31 years. The number of patients in the age group on the extremes such as 14 years and 80 years were least in our study. The mean of the sample population was 34.72 and the standard deviation was 14.48.

The mean age in the male group was 35.14 years. The mean age in the female group was 33.52 years. As the p-value was >0.05, this difference of the group was not statistically significant.

AGE GROUP (IN YEARS)	NO. OF PATIENTS
10 – 15	6
15 – 20	10
20 – 25	27
25 – 30	35
30 – 35	17
35 – 40	13
40 – 45	10
45 – 50	10
50 – 55	9
55 – 60	6
60 – 65	1
65 – 70	3
70 – 75	3
75 – 80	2
TOTAL	152

TABLE 6 – NO. OF PATIENTS IN VARIOUS AGE GROUPS

FIGURE 9 – COUNTS IN VARIOUS AGR GROUOS



The above figure shows the number of patients in each age group of the study population. We could note that most of the patients are below 40 years of age. We could also see that the extremes of age group has the least number of patients whereas maximum number of patients belong to the age group between 25 and 30 years.

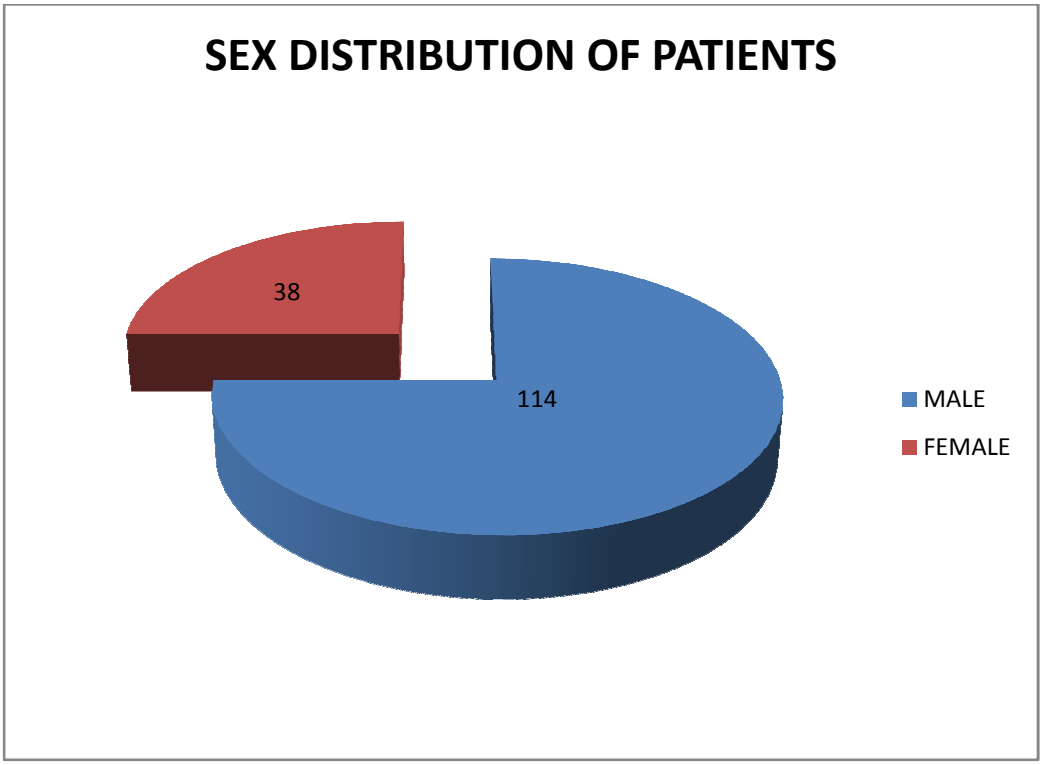


FIGURE 10 – SEX DISTRIBUTION OF PATIENTS

Among the 152 patients under study, 114 patients were male and the rest of the 38 patients were female. There were no transgender in the study population. In proportionate comparison, 75% of the study population were male and 25% of the study population were female. This gives us a male : female ratio of 3 : 1.

			GENDER		Total
			MALE	**FEMALE**	
SETTING OF LAPARATOMY	**EMERGENCY**	Count	100	32	132
		% of Total	65.8%	21.1%	**86.8%**
	ELECTIVE	Count	14	6	20
		% of Total	9.2%	3.9%	**13.2%**
Total		Count	114	38	152
		% of Total	**75.0%**	**25.0%**	100.0%

TABLE 7 – LAPAROTOMY & GENDER

The above table shows us the gender relationship with the setting of laparotomy. There was no statistical significant difference between the genders ($x^2 = 0.307$, $p = 0.579$).

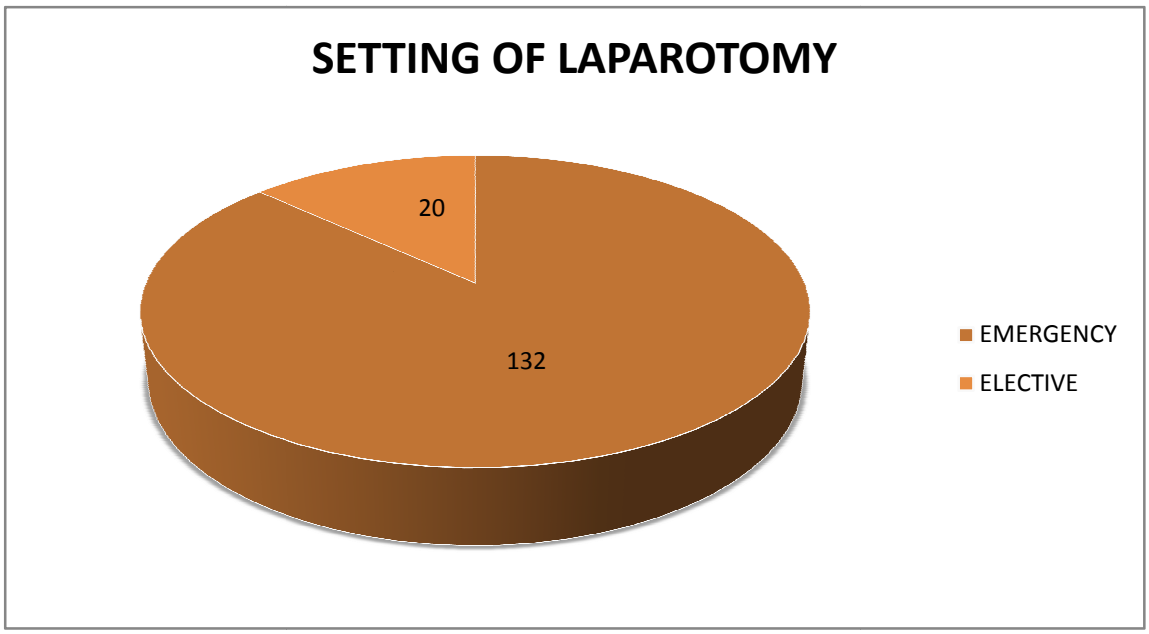


FIGURE 11 – PATIENTS IN VARIOUS LAPAROTOMY SETTINGS

From the above table and chart, we could note that the majority of the surgeries were in the emergency setting and only few surgeries were in the elective settings. 132 patients were operated as an emergency and only 20 patients were operated electively. 86.8% of the surgeries were emergency laparotomies and only 13.2% of the surgeries were elective. This shows our efficient functioning and round the clock services of our emergency theatres.

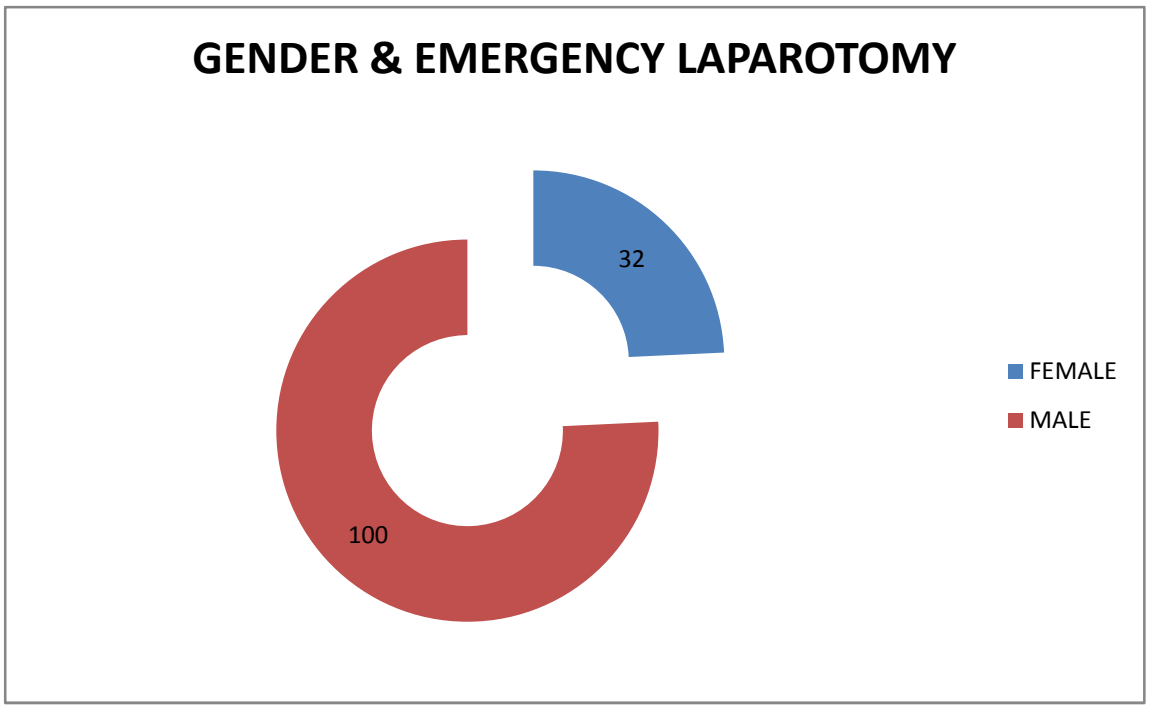


FIGURE 12 – GENDER AND EMERGENCY LAPAROTOMY

100 male patients were taken up for emergency laparotomies and 32 female patients were taken up for emergency laparotomies. Among the 86.8% of total emergency laparotomies, 65.8% of the patients were male patients and 21.1% of the patients were female patients.

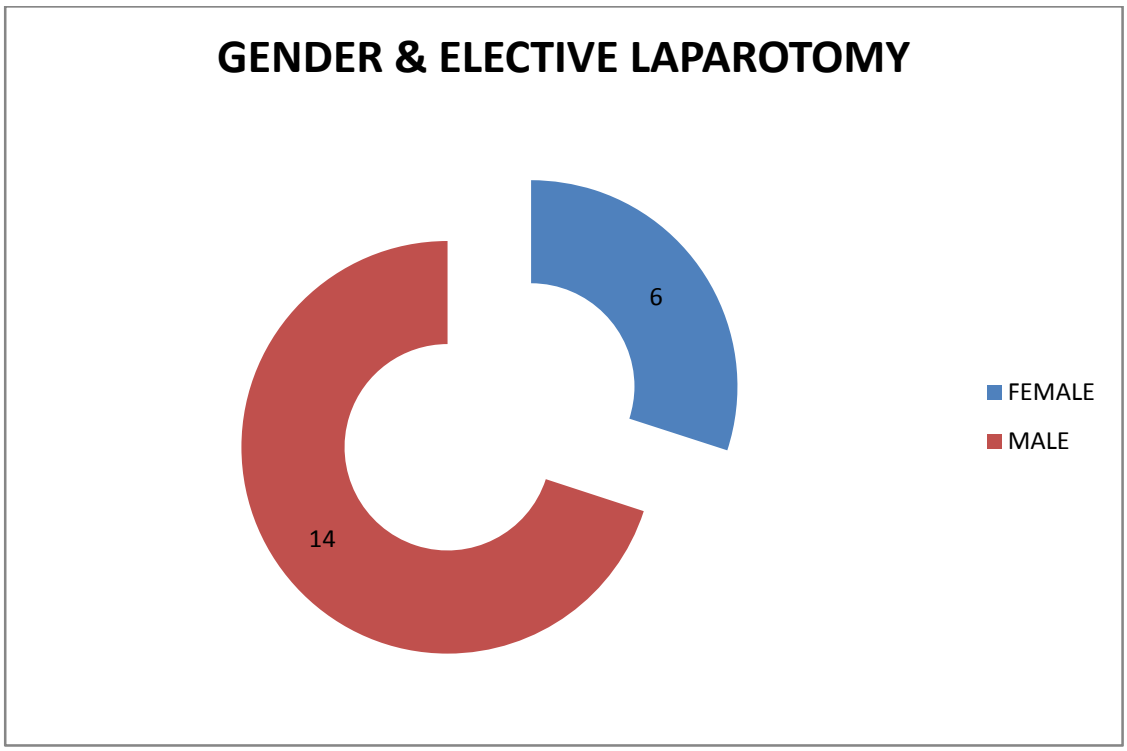
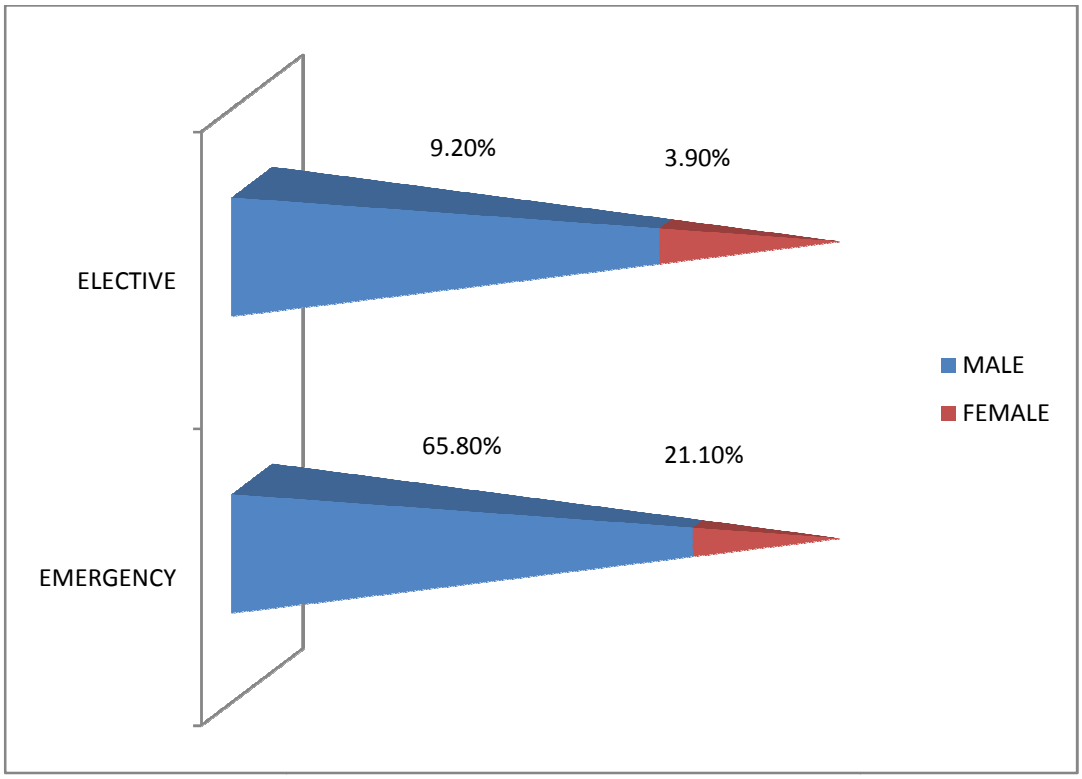


FIGURE 13 – GENDER AND ELECTIVE LAPAROTOMY

From the above pie chart, it is evident that 14 patients who were taken for elective laparotomies are male and 6 patients who were taken for emergency laparotomies were female. So in a proportionate analysis, 9.2% were male and 3.9% were female. In both elective and emergency settings, male group predominated when compared to the female group.

It can also be observed from the above table, of the total 114 male patients, 100 patients were taken for emergency laparotomy and 14 patients were taken up for elective laparotomy. 65.8% of the 75% male patients underwent emergency laparotomy and 9.2% underwent elective laparotomy.

Of the total 38 female patients, 32 patients were taken for emergency laparotomy and 6 patients were taken up for elective laparotomy. 21.1% of the 25% female patients underwent emergency laparotomy and 3.9% underwent elective laparotomy.



FIGUE 14 – GENDER AND LAPAROTOMY SETTING

Penetrating abdominal injury is the most common cause for taking the patients for laparotomy constituting 19.7%. The other common causes include intestinal obstruction and peritonitis both of which contributing 15.1% each. Laparotomy for perforated peptic ulcer is the next common cause 11.8%. Surgery for blunt injury abdomen constitutes 10.5%. Intra-abdominal abscess contributes to 9.2%. Minor causes of laparotomies

include cholelicystitis 1.9%, mesenteric ischemia 1.3%, obstructed hernia 2.6%, and hydatid cyst 0.6%. The causes classified as Other contributes to 11.8% which includes surgeries for cancer stomach, cancer colon, liver abscess, pseudocyst of pancreas and whipples procedure.

TABLE – 8 : DIAGNOSIS & NO. OF PATIENTS

DIAGNOSIS	COUNT %	COUNT (NO)
Cholelicystitis	1.9	3
Mesentric ischaemia	1.3	2
Hernia	2.6	4
Hydatid cyst	0.6	1
Intra-abdominal abscess	9.2	14
Blunt injury	10.5	16
Perforation	11.8	18
Peritonitis	15.1	23
Intestinal obstruction	15.1	23
Penetrating injury	19.7	30
Others	11.8	18

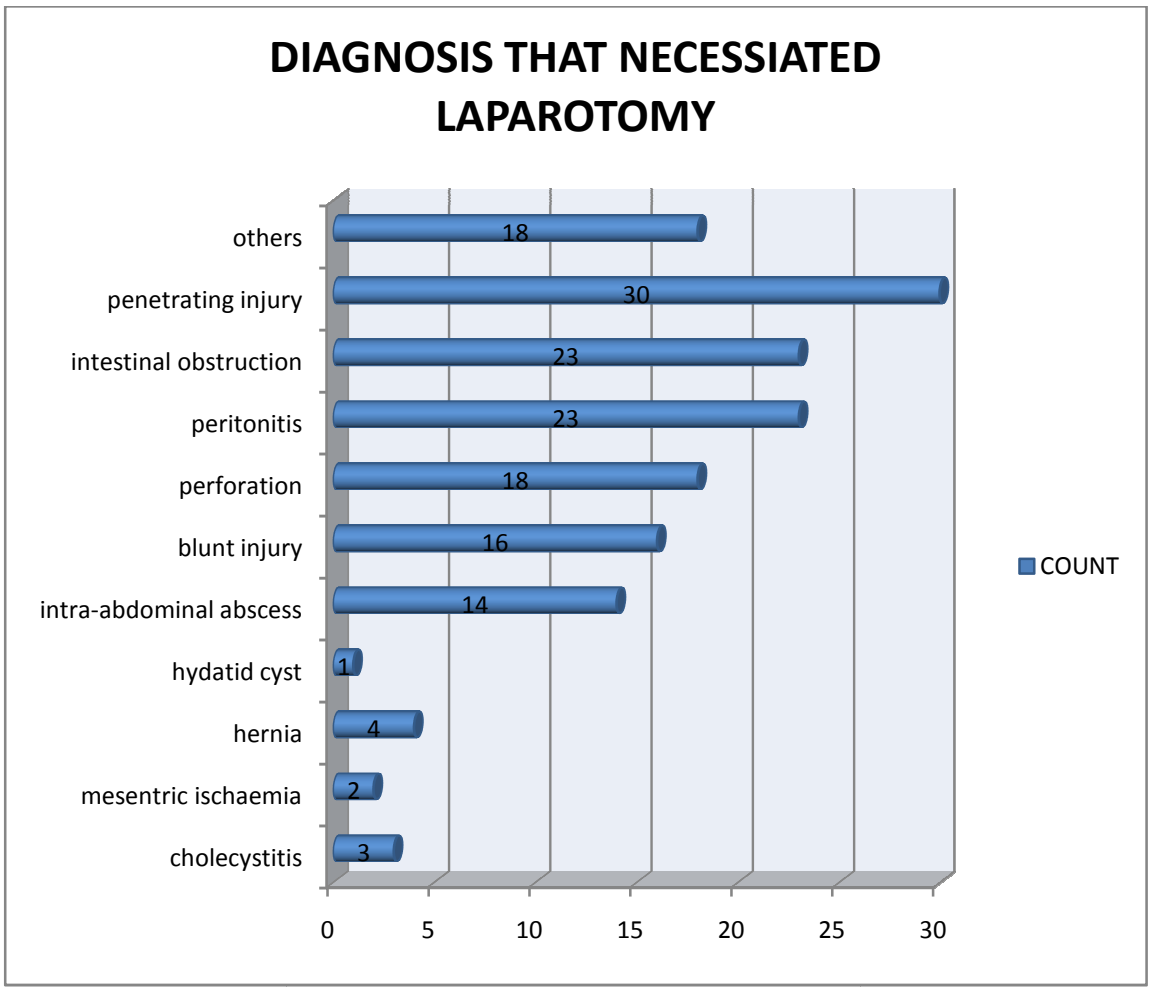
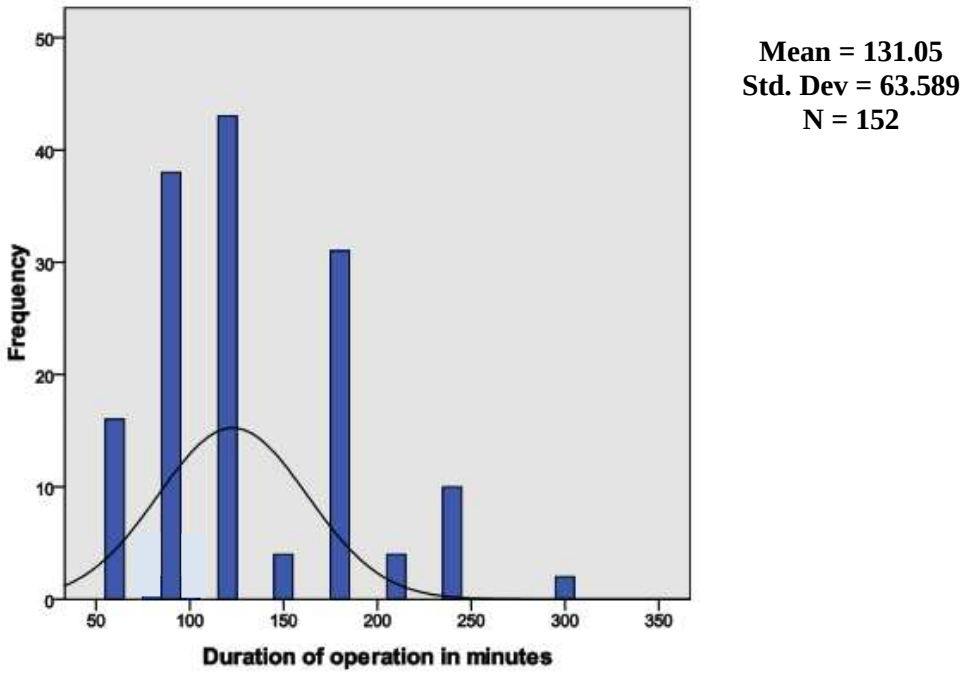


FIGURE 15 – VARIOUS ETIOLOGIES FOR LAPAROTOMY

The above table and bar chart shows the distribution of diagnoses that necessitated laparotomy in a simplified manner. The most common causes in descending order include penetrating injury, intestinal obstruction, peritonitis, perforated duodenal ulcer, blunt injury abdomen, intra-abdominal abscess, hydatid cyst, obstructed hernia, mesenteric ischaemia, cholecystitis and other causes.

Duration of the laparotomies that were performed varied from about 1 hour to about 5 hours that is from about 60 minutes to about 300 minutes. Mean duration was 131.05 minutes and the median duration of the surgeries was 120 minutes. The standard deviation observed was 63.589.

FIGURE 16 – NO OF PATIENTS IN DIFFERENT SURGERY DURATION



Observing the study, it has to be noted that out of the 152 patients, 12 patients died within 30 days of the laparotomy procedure. This makes it a mortality rate of 7.9%. Most of the deaths occurred within the first 16 days post-surgery from the 1st to 16th post-operative day. It is also

worthwhile mentioning that most of postoperative mortality in the study occurred in the first postoperative day.

The death of 12 patients leaves us with 140 patients. When the profile of the 140 patients were analyzed, it can be noted that 50 patients suffered major complications within the 30 day postoperative period of study. This is a 40.8% complication rate that occurred in the study.

Deep wound infection was the most common complication. The second to it comes the anastamotic leakage. The next common complication was found to be superficial wound infection. The other complication that was commonly noted were wound dehiscence, renal dysfunction and respiratory infection.

90 patients of the total 152 patients did not suffer from any complications within the first 30 postoperative days. This is a 59.2% complication free patients amongst the total patients in the study.

TABLE 9 – FREQUENCY OF COMPLICATIONS

COMPLCATIONS	FREQUENCY	PERCENT
No complications	90	59.2
Anastamotic leakage	12	7.9
Renal dysfunction	4	2.6
Death	12	7.9
Superficial wound infection	11	7.2
Deep wound infection	14	9.2
Respiratory infection	1	0.7
Wound dehiscence	8	5.3
TOTAL	**152**	**100**

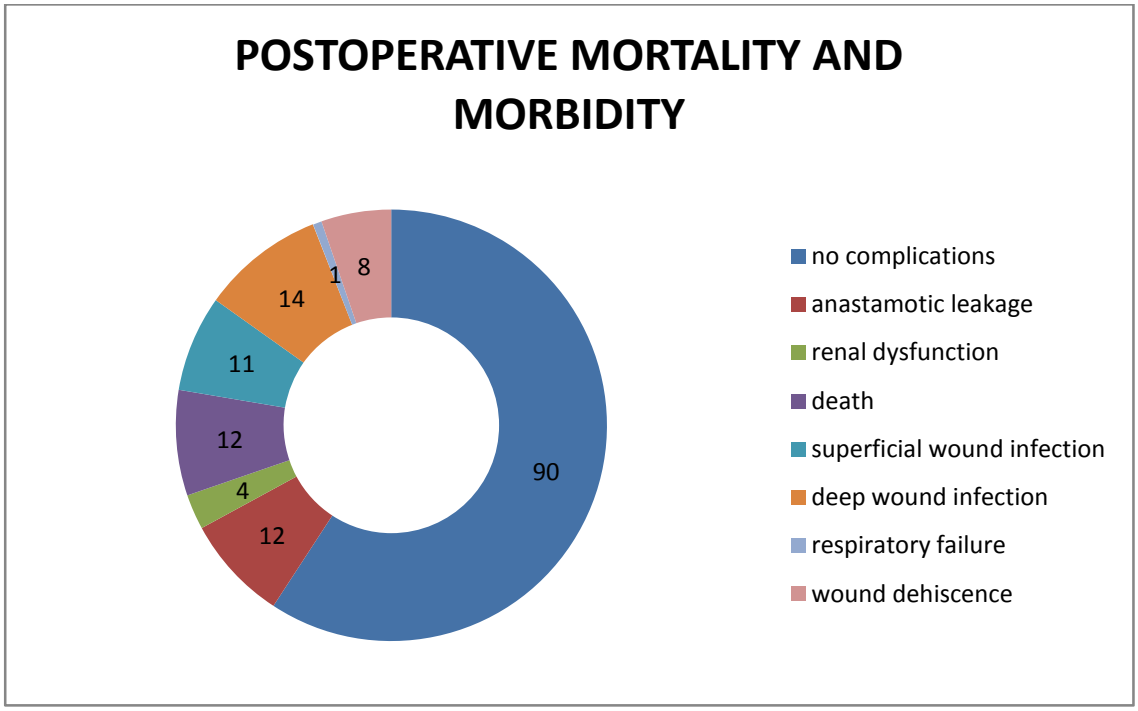


FIGURE 17 – POSTOPERATIVE MORTALITY & MORBIDITY

A significantly higher complication was noted among female patients at 63.2% compared to male patients at 33.3%.

43.9% of the postoperative complications occurred in emergency setting whereas only 20% of the complications occurred in the elective setting.

When the complications were compared with the duration of surgery, those surgeries that lasted more than 120 minutes had a higher complication rate of 68.6% whereas surgeries with a shorter duration only had a complication rate of 26.7%.

The following table shows the relationship between occurrence of complications versus gender, setting of laparotomy, age and duration of surgery. P values were generated using chi-square test.

			Presence or absence of complication		Total	X^2	P value
			Absent	Present			
Gender	Male	Count % within GENDER	76 66.70%	38 33.30%	114 100.00%	10.497	0.001
	Female	Count % within GENDER	14 36.80%	24 63.20%	38 100.00%		
Setting of laparoromy	Emergency	Count % within SETTING OF LAPAROTOMY	74 56.10%	58 43.90%	132 100.00%	4.121	0.042
	Elective	Count % within SETTING OF LAPAROTOMY	16 80.00%	4 20.00%	20 100.00%		
Age group	<40 yrs	Count % within AGE GROUP	54 51.40%	51 48.60%	105 100.00%	8.515	0.004
	40 and above	Count % within AGE GROUP	36 76.60%	11 23.40%	47 100.00%		
Duration group	120 minutes or less	Count % within DURATION GROUP	74 73.30%	27 26.70%	101 100.00%	24.628	<0.001
	>120 minutes	Count % within DURATION GROUP	16 31.40%	35 68.60%	51 100.00%		

TABLE 10 – FACTORS PROVOKING COMPLICATIONS

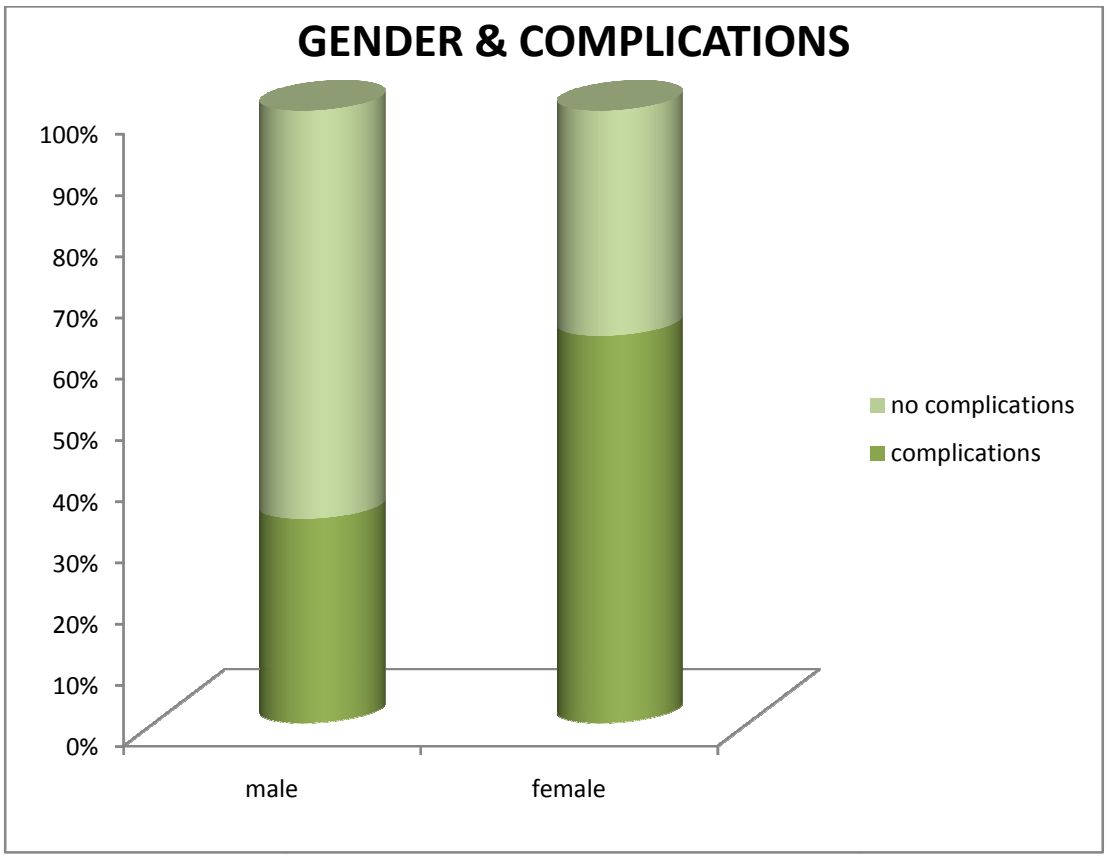


FIGURE 18 – GENDER & COMPLICATIONS

The female patients presented with more complications when compared to the male group. There was a documented 63.20% complication rate in the female group when compared to 33.30% complication rate in the male group. 24 patients of the total 38 female patients developed complications whereas only 38 patients of the total 114 male patients developed complications.

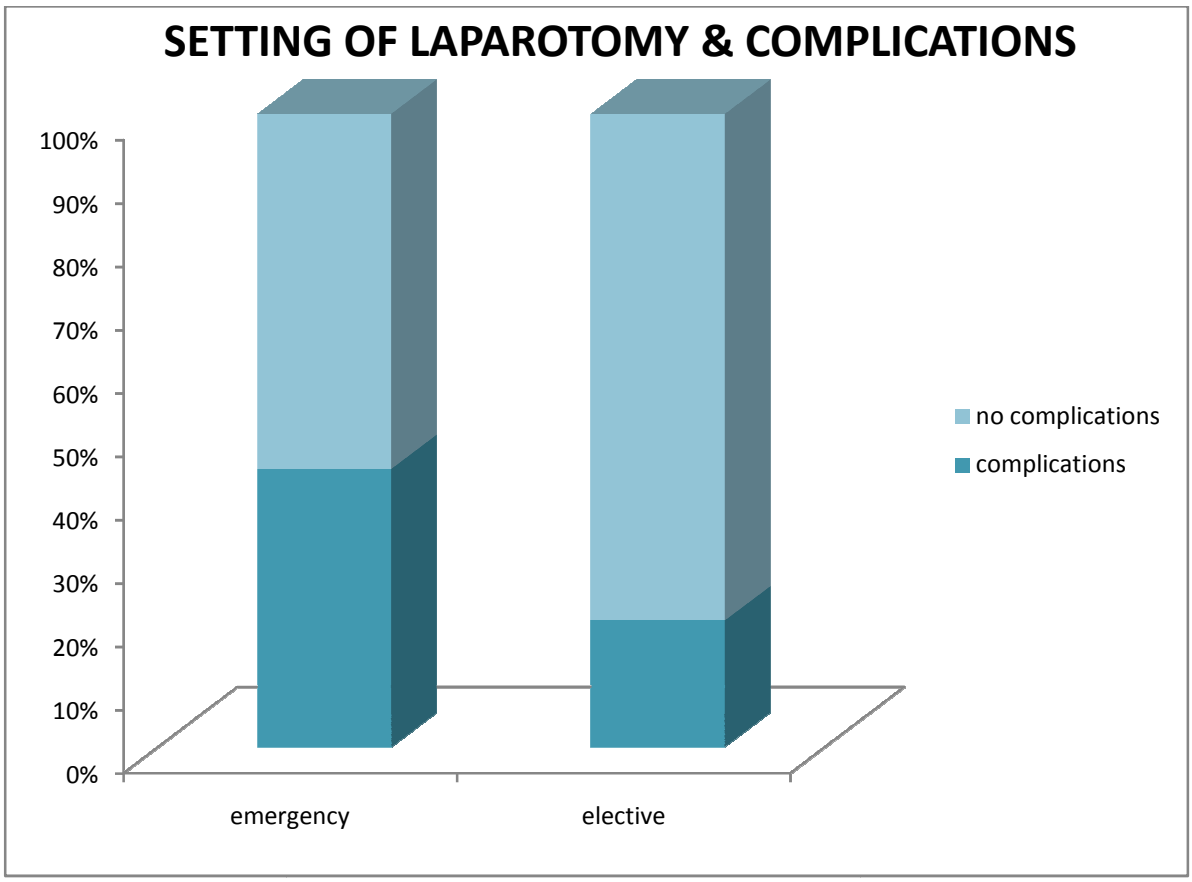


FIGURE 19 – LAPAROTOMY SETTING & COMPLICATIONS

The emergency setting of surgery presented with more complications when compared to the elective surgery. There was a documented 43.90% complication rate in the emergency scenario when compared to 20% complication rate in the elective scenario. 58 patients of the total 132 patients who underwent emergency laparotomy developed complications whereas only 4 patients of the total 20 patients who underwent elective laparotomy developed complications.

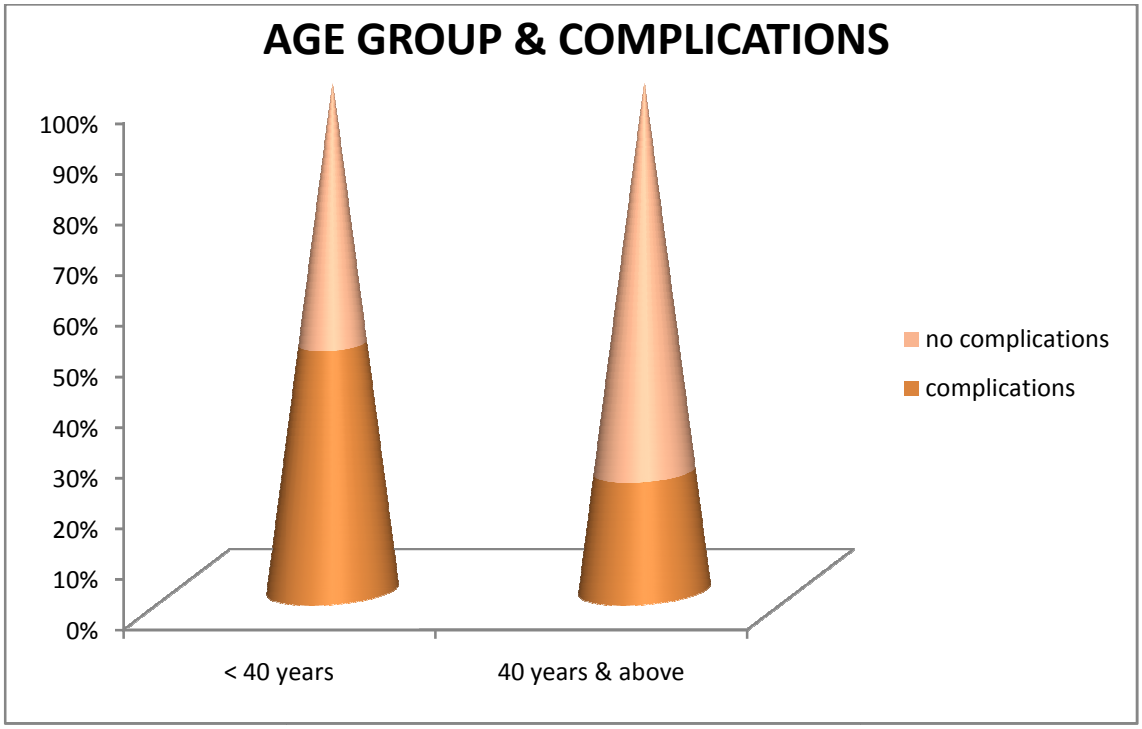


FIGURE 20 – AGE GROUP & COMPLICATIONS

It can be noted from above that, on the contrary, patients less than 40 years of age presented with more complications compared to patients of age 40 years and above. 48.6% of patients less than 40 years developed complications whereas only 23.4% of patients 40 years and above developed complications. In other words, 51 patients of total 105 patients less than 40 years developed complications compared to 11 patients of total 47 patients above 40 years who developed complications.

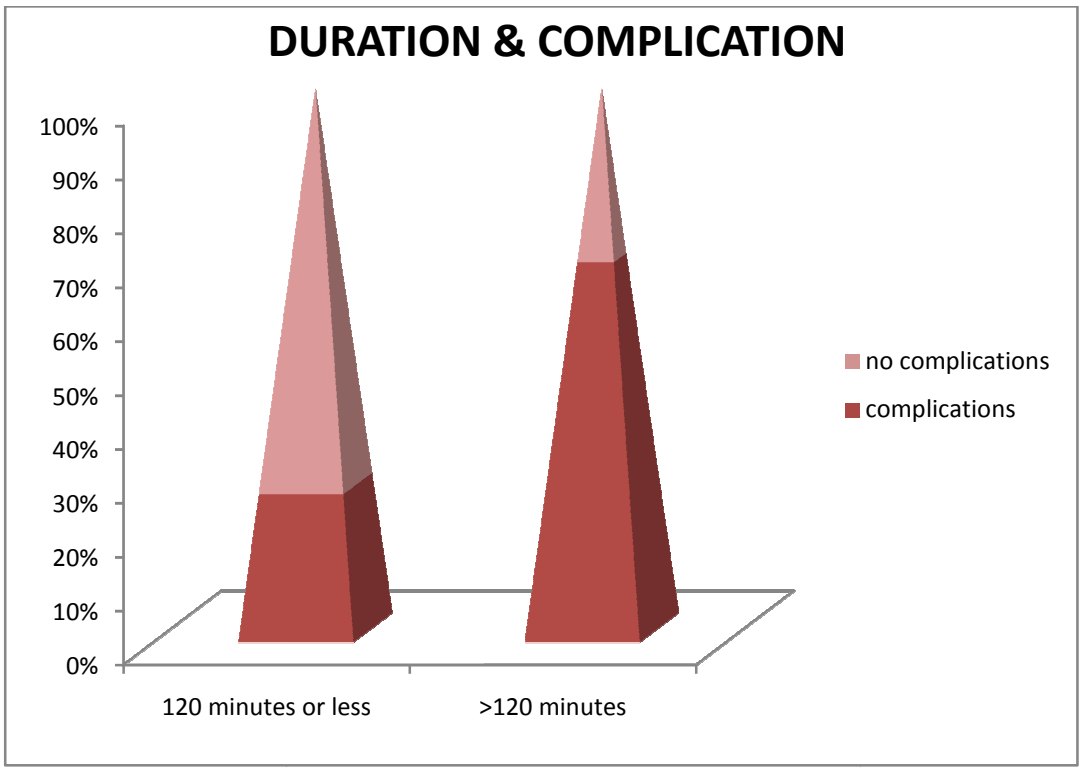


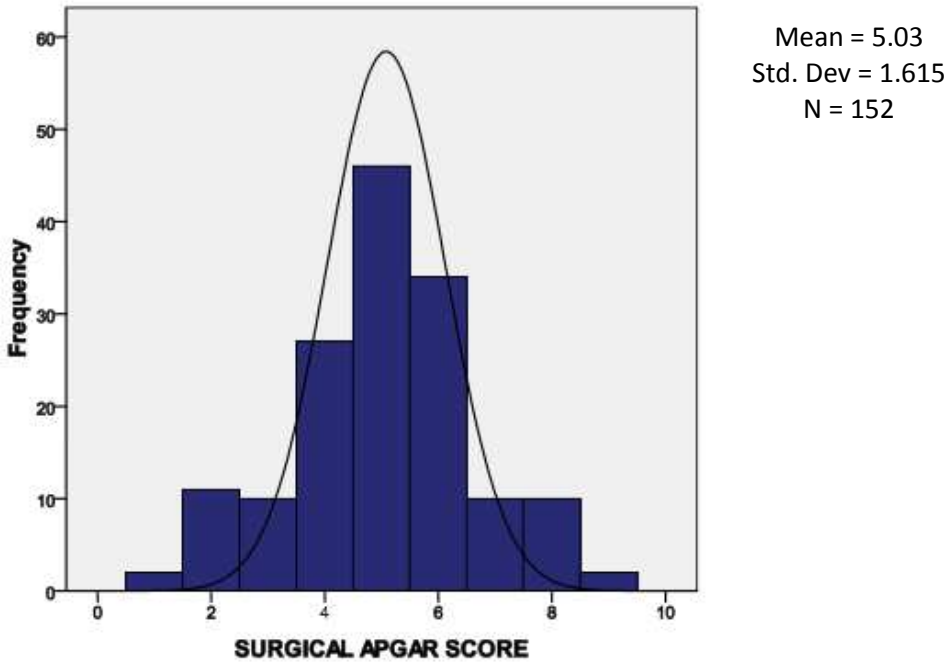
FIGURE 21 – DURATION & COMPLICATIONS

Surgeries lasting for less than 2 hours presented with less complications compared to surgeries lasting more than 2 hours. 26.7% of patients who underwent surgeries for less than 2 hours developed complications whereas 68.6% of patients who underwent surgeries for more than 2 hours developed complications. In other words, 27of total 101 surgeries that lasted less than 2 hours developed complications compared to 35 of total 51surgeries that lasted more than 2 hours developed complications.

In our study, the Surgical Apgar Score that was computed for all the patients ranged from 1 to 9. The mean was 5.03 and the median was 5. The mean SAS for males was 5.28 while for females it was 4.26. This was statistically significant (p=0.001).

The below figure shows the mean, standard deviation and distribution of the calculated Surgical Apgar Score.

FIGURE 22 – NO OF PATIENTS IN VARIOUS SAS



The following table show the comparison of the mean SAS between different patient groups based on duration of surgery, gender, age group and occurrence of complications. P values were generated using ANOVA tables.

SURGICAL APGAR SCORE

DURATION OF LAPAROTOMY	Mean	N	Std. Deviation	F	p
120 MIN OR MORE	5.52	101	1.432	35.153	<0.001
➢ 120 MIN	4.04	51	1.509		
Total	5.03	152	1.615		

GENDER	Mean	N	Std. Deviation	F	p
MALE	5.28	114	1.549	12.147	0.001
FEMALE	4.26	38	1.589		
Total	5.03	152	1.615		

AGE GROUP	Mean	N	Std. Deviation	F	p
<40 YRS	4.80	105	1.608	6.929	0.009
40 AND ABOVE	5.53	47	1.530		
Total	5.03	152	1.615		

PRESENCE OR ABSENCE OF COMPLICATIONS	Mean	N	Std. Deviation	F	p
ABSENT	5.73	90	1.364	58.336	<0.0001
PRESENT	4.00	62	1.391		
Total	5.03	152	1.615		

TABLE 11 – CALACULATED SAS IN DIFFERENT PATIENT GROUPS

The following table shows the distribution of different complications within different risk groups of patients. Most complications types apart from renal dysfunction are more common in the high and medium risk groups.

Type of complications		Risk group			Total
		High risk	Medium risk	Low risk	
	Count	20	58	12	90
Anastamotic leakage	Count % within risk group	8 16.7%	4 4.4%	0 0%	12 7.9%
Renal dysfunction	Count % within risk group	0 0%	2 2.2%	2 14.3%	4 2.6%
Death	Count % within risk group	4 8.3%	8 8.9%	0 0%	12 7.9%
Superficial wound infection	Count % within risk group	5 10.4%	6 6.7%	0 0%	11 7.2%
Deep wound infection	Count % within risk group	6 12.5%	8 8.9%	0 0%	14 9.2%
Pyrexia of unknown origin	Count % within risk group	1 2.1%	0 0%	0 0%	1 0.7%
Wound dehiscence	Count % within risk group	4 8.3%	4 4.4%	0 0%	8 5.3%
Total	Count % within risk group	48 100%	90 100%	14 100%	152 100%

TABLE 12 – RISK GROUPS & COMPLICATIONS

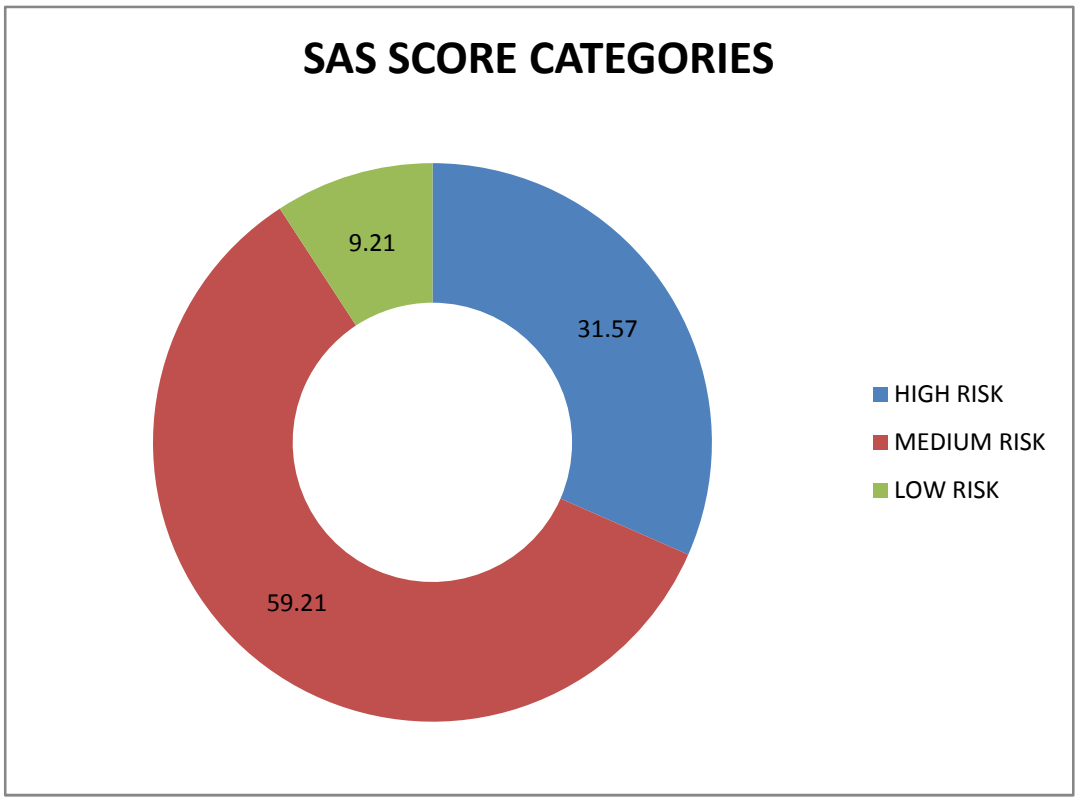


FIGURE 23 – SAS SCORE CATEGORIES

Following points are clearly evident from the above pie diagram. On applying the Surgical Apgar Score to our study population, 31.57% of the patients belonged to the high – risk group, 59.21% of the patients belong to the medium – risk group and only about 9.21% of the patients who underwent laparotomy beloned to the low – risk group.

COMPLICATION TYPES IN DIFFERENT RISK GROUP

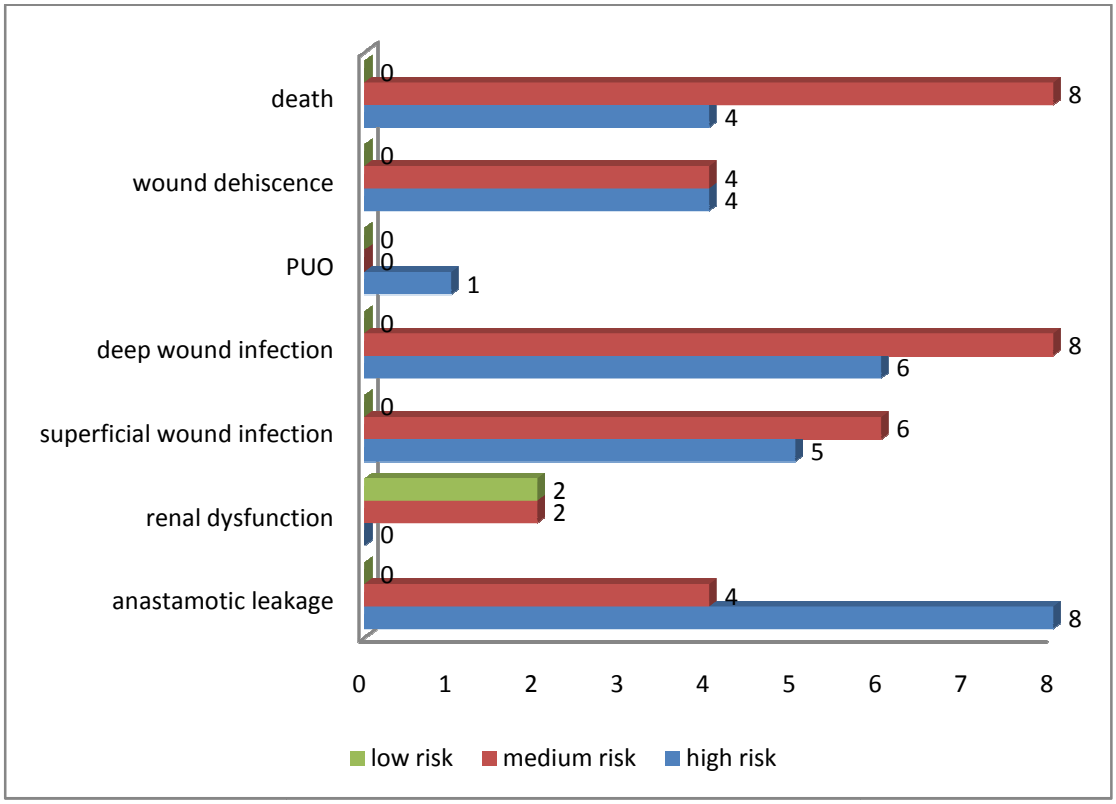
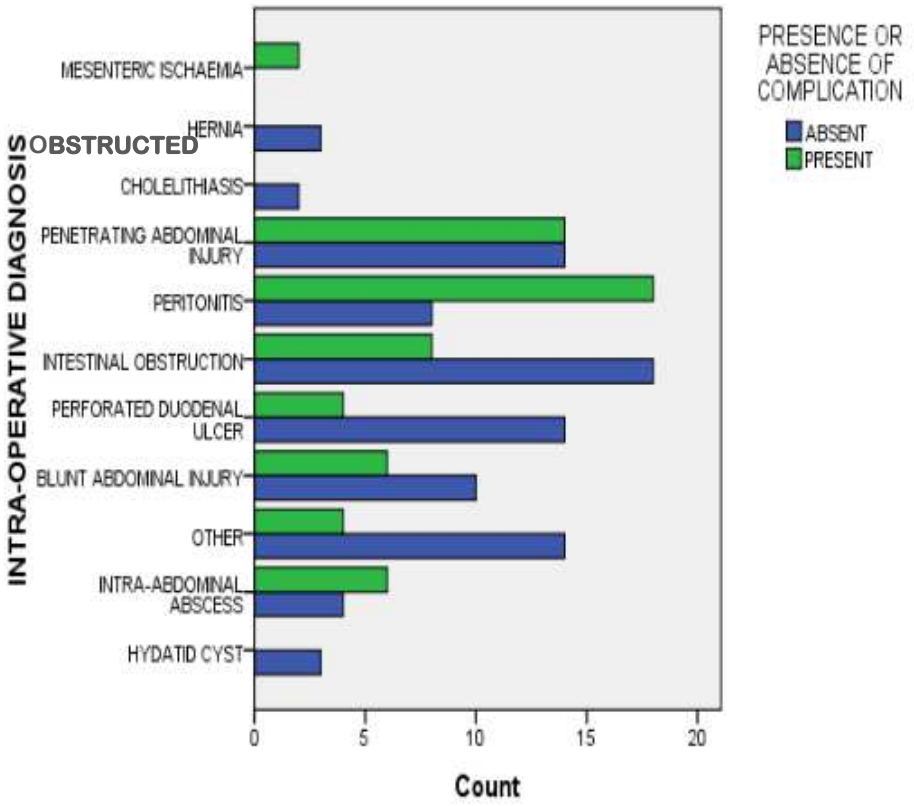


FIGURE 24 – COMPLICATION TYPES IN DIFFERENT RISK GROUPS

From the above bar diagram, it is evident that most of the postoperative complications are common in high risk and medium risk groups. The count is least and almost nil in the low risk groups. We can also notice that death is also more only in the high and medium risk groups and nil in the low risk groups. Only contrast to this in our study is the renal dysfunction which is more common in medium and low risk group and almost nil in the high risk group.

The below diagram shows the relationship between diagnosis and the occurrence if complications in the setting of elective and emergency laparotomy.

FIGURE 25 – INTRAOPERATIVE DIAGNOSIS & COMPLICATIONS



We can see from the above chart that the major complications were more common in patients with peritonitis, intra-abdominal abscess and penetrating abdominal injury. Complications are almost nil in straightforward surgeries which are easier and takes less duration such as obstructed hernia, cholelithiasis and hydatid cysts.

This table is the most significant table of our study. It analyses the presence or absence of complications on each risk and its statistical significance by means of ‘pvalue’.

Risk group	Presence or Absence of complication		Total	X2/F	p value
	Absent	Present			
High risk	20 (41.7%)	28 (58.3%)	48	X2=11.2	0.04
Medium risk	58 (64.4%)	32 (35.6%)	90		
Low risk	12 (85.7%)	2 (16.6%)	14		
Total	90 (59.2%)	62 (40.8%)	152		

Mean Surgical Apgar Score	5.73	4.00	[redacted]	F=58.336	0.00

TABLE 13 – SAS & COMPLICATIONS

FIGURE 26 – RISK GROUP & COMPLICATIONS (IN NUMBER)

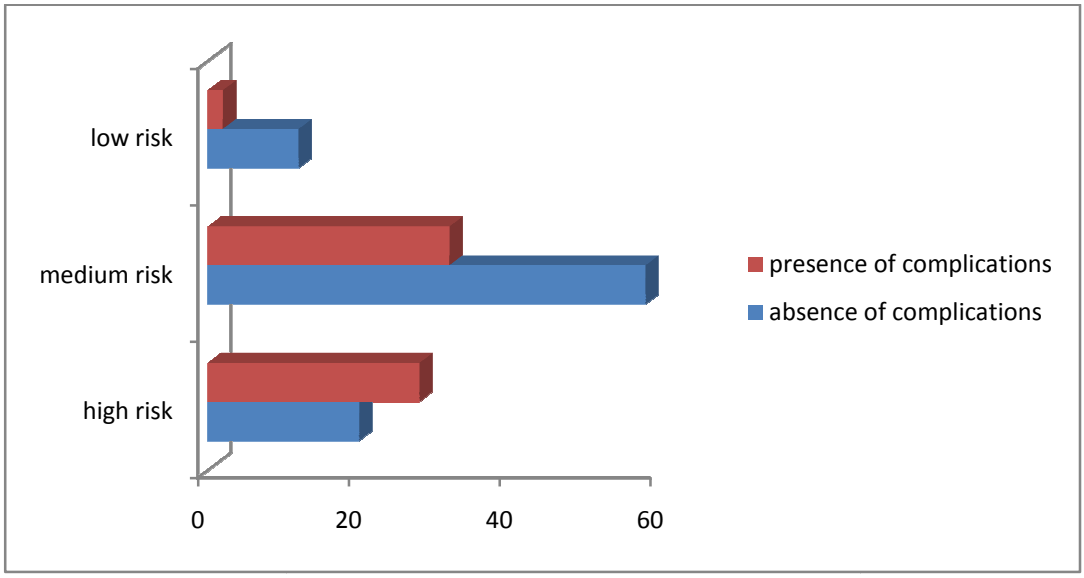
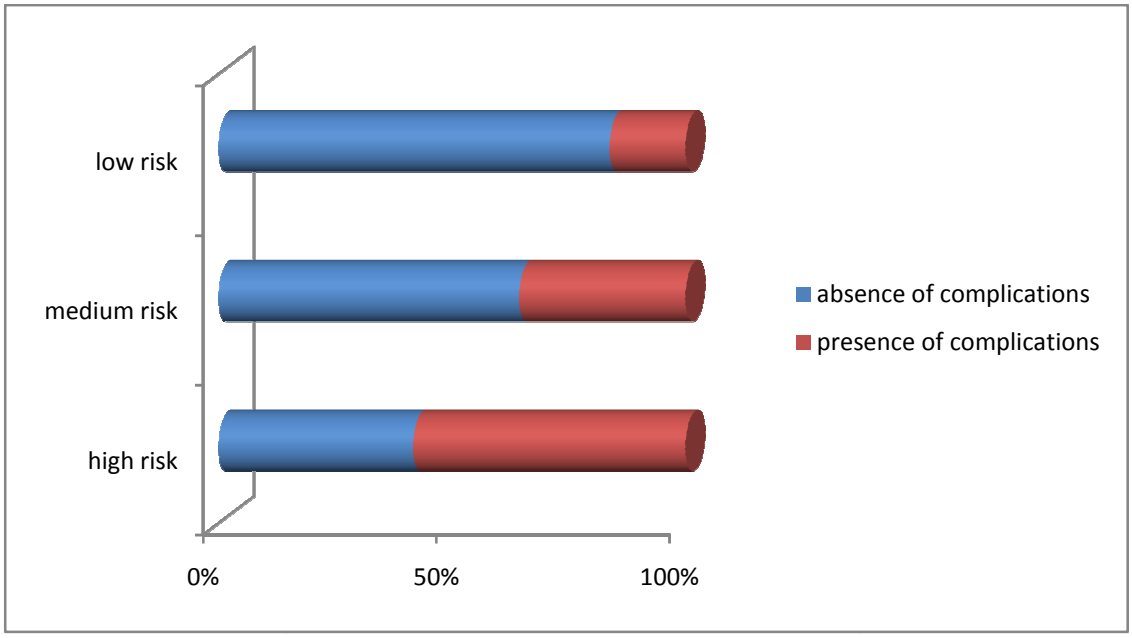


FIGURE 27 - RISK GROUP & COMPLICATIONS (IN %)



It can be seen from the first chart in the previous page, of the 48 patients in the high risk group, 28 patients had complications and 20 patients had no complications. Of the 90 patients in the medium risk group, 32 had complications and 58 had nil complications. Only 2 patients of the total 14 patients in the low risk group developed complications whereas rest of the 12 patients did not have any complications.

In the high-risk group, 58.3% had complications and 41.7% had no complications. 35.6% of the patients in the medium-risk group developed complications whereas 64.4% of the patients developed no complications. Amongst the low-risk groups, only 16.6% patient developed complications and the rest 85.7% did not suffer from any complications.

From the table, we could observe that, the patients with complications (4.00) had a significantly lower mean SAS compared to those patients without complications (5.73) ($p=0.00$). The complication rate within the high-risk group was 58.3% compared to 35.6% in the medium- and 16.6% in the low-risk group. This was also statistically significant ($p=0.04$).

DISCUSSION

DISCUSSION

The key purpose of this work is to establish the usage of the Surgical Apagr Score in the stratification of the post-operative risks for patients undergoing laparotomy in Rajiv Gandhi Government General Hospital, Chennai. The Surgical Apgar Score is a very effective tool which helps us in finding out the patients with higher than the normal risk of post-surgical complications. Laparotomy is the most common surgery performed in the General Surgery department of this hospital. Many studies that have been performed at yesteryears have shown a significant postoperative mortality and morbidity following the surgery.

152 patients were studied in detail in this prospective study. The mean age in this study was 35.18 years. This study had a skewed distribution of gender with 75% of patients being male. Similar composition was seen in the study performed by Mwangi et al in which there was a 67% male preponderance with a average age of approximately 34.8 years. This slightly contradicts with the studies on SAS performed in the Western countries in which the average age of the patients who underwent laparotomy was found to be much older. Mean age in the study conducted by Regenbogen et al in 2009 was recorded to be 64.2 years. The average age of the patient population in the study conducted by Gawande et al is found to be 63.6 years.

In our study conducted at our hospital, the most common reason for laparotomy is penetrating abdominal injury. This is18.4% of the overall cause of laparotomy. The second and third common cause of laparotomy in our study was peritonitis and intestinal obstruction. Both contributed to 17.1% each. Peritonitis, intestinal obstruction and appendicitis was the most common reason for laparotomy in the study conducted by Mwangi et al in 2007.

Our study had a mortality of 7.9% in the first thirty days postoperatively. This is found to be comparatively high when compared with the studies by Mwangi et al and Yii and Ng. A 30-day mortality of 4.8% was recorded by Mwangi et al. In a study conducted by Yii and Ng in 2009 in Malaysia, a 30-day mortality of 6.1% was seen. A mortality of 5.2% was observed in the study conducted by Regenbogen and colleagues in 2010 in patients who underwent mortality for gastrectomy and colectomy. A 4% mortality rate in patients who underwent colectomy was observed by Gawande et al in 2007.

The efficacy and the talent of the surgeon and his team is mainly compared by the surgical mortality of the patients they are operating upon. The surgical mortality acts as a surrogate marker in assessing their performance. Sometimes this can be misleading because of the variations

in the case mix as can be observed in the differences between the subjects of our study and that of the study conducted by Mwangi et al in 2007.

In our study, it could be seen that emergency laparotomy is the major cause for the development of major postoperative complications when compared to elective laparotomies. This was also found to be similar to the study conducted by Mwangi et al (2007) in which emergency laparotomy was found to be the common cause of significant postsurgical morbidity and mortality. Female sex, 40 years or lesser age and surgery time more than 2 hours are other noted factors in our study that was found to be associated with a significantly higher rates of complications.

Regenbogen et al (2009) proved a similar relationship between higher rates of complication and female sex. The p value was significant being less than 0.001 ($p<0.001$). But in the study conducted by Gawande et al (2007), there was no statistical significant difference or association ($p=0.07$). Even in our study, significantly lower SAS was seen in female gender. This correlates with a higher complication rate observed in the female gender.

Most of the studies on Surgical Apgar Score have established long duration of surgery as one of the major important factor in the development of significant postoperative complications. This might be

due to the complexity of the surgery necessitated by possibly extensive disease. But it can also be observed in our study that, long duration of surgery and a low mean Surgical Apgar Score is having a strong association.

Young patients were associated with a significantly higher rate of complications in our study. This can be explained by a lower mean Surgical Apgar Score in patients less than 40 years of age in our study. This contradicts with the observation of Gawande et al (2007) and Regenbogen et al (2009) in which patients in the elderly age group were associated with a higher postoperative complication.

From our study we can interpret that, patients having a SAS 0f 0 – 4 who belong to the high risk group had a higher complication rate of 58.3% when compared with the patients having a score of 8 – 10 who belong to low risk group. This group had a lower complication rate of 16.6%. A complication rate of 54-75% is seen in patients with scores between 0 – 4 and a complication rate of 5 – 13% is seen in patients with scores between 7 – 10 in the study conducted by Regenbogen et al(2009). This clearly demonstrates the efficacy of the Surgical Apgar Score in selecting patients who are at a higher risk of developing major complications from patients who are at an average risk of developing complications.

This simple tool like the Surgical Apgar Score would be very useful in developing countries like India. It would be helpful in the routine risk stratification of postoperative patients which will facilitate in the easy identification of patients at high risk. In a healthcare setting like India, where only limited resources are available, SAS score would guide us in planning and managing the limited resources towards the post-surgical management, monitoring and follow up of deserving high risk patients. This would thereby prevent the wastage of resources in monitoring of low risk patients where it is actually not needed.

Studies that indicate a link among intra-operative anesthetic and surgical performance and Surgical Apgar Score suggest the possibility of using the score in surgical audit. The SAS can also be used as a tool to improve the performance if it is serially monitored within a unit. However, a more number of studies on other surgical specialties are also required on this aspect.

CONCLUSION

CONCLUSION

This study concludes that:

- Laparotomy is still associated with significant morbidity and mortality in our setting.
- The Surgical Apgar Score, despite using simple and wide variable intraoperative parameters, is efficacious in stratification of postoperative risk of major complication following laparotomy.

SUMMARY

The efficacy of the Surgical Apgar Score in identifying high risk individuals developing postoperative complications following laparotomy is studied in 152 patients admitted in both emergency as well as general wards.

The Surgical Apgar Score was calculated from the lowest heart rate, lowest mean arterial pressure and the amount of blood lost during the surgery from the anaesthetic notes. From the Surgical Apgar Score calculated, patients are stratified into high-risk, moderate-risk and low-risk. The patients belonging to various risk groups were monitored for 30 days postoperatively for the development of major complications.

The following points must also be highlighted from our study. Surgeries especially laparotomy lasting for more than 120 minutes is associated with higher complication rate. Patients belonging to age less than 40 years had a lesser rate of complication when compared to patients more than the age of 40 years. This point was contrary to the previous studies. Furthermore, patients belonging to female gender also had a higher complication rate following surgery compared to their male counterparts.

It has been observed in our study that, 28 patients of the total 48 patients in the high risk group developed complications. In other words, 58.3% of the patients in the high risk groups developed complications whereas the rest 41.7% did not develop any complications. 32 patients of the total 90 patients belonging to the medium risk group developed complications whereas the rest 58 patients did not develop any complications. In other words, 35.6% of medium risk group patients developed significant postoperative morbidity and mortality. The rest of the 64.4% patients belonging to the medium risk group had an uneventful postoperative period following the laparotomy. Only 2 patients of the total 14 patients in the low risk group suffered from complications. 85.7% of the patients in the low risk groups did not have any major complications following the surgery whereas only 16.6% had significant complications. This was statistically significant with a p-value of 0.04.

This shows that Surgical Apgar Score is very effective in identifying high risk patients who are capable of developing significant complications following laparotomy within the first 30 postoperative days. This identification of high risk patients helps us in the judicious use of healthcare resources towards the proper monitoring and follow up of these patients. Unnecessary use of resources towards low risk patients results in wastage of these resources. This can be diverted to the

deserving high risk groups. With proper use of healthcare facility towards proper patients, postoperative morbidity and mortality can be significantly reduced. This study shows that Surgical Apgar Score plays a major role in helping the healthcare professionals in achieving this goal.

RECOMMENDATIONS:

Since this study is statistically significant, this study can be used in our hospital setup to calculate the possible postoperative morbidity and mortality during the intraoperative procedures and necessary steps can be taken to prevent the occurrence of such complications.

DRAWBACKS:

This study needs to be done on a broader scale involving similar hospitals in a much longer duration of time with large proportion of population so that the value of the score on a larger scale could be assessed. Amount of blood lost during the surgery could not be accurately measured leading on to minor errors. This can again be prevented by using newer techniques like applications which can accurately detect the blood loss based on visual recognitions. Meticulous recording of the parameters are also essential which might be tiresome in long duration surgeries.

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BIBILOGRAPHY

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ANNEXURES

APPENDIX I

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI 600 003

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
Fax: 011 25363970

CERTIFICATE OF APPROVAL

To
Dr.P.Vijaya Raghavan
Post Graduate in M.S. (General Surgery)
Madras Medical College
Chennai 600 003

Dear Dr.P.Vijaya Raghavan,

The Institutional Ethics Committee has considered your request and approved your study titled **"UTILITY OF SURGICAL APGAR SCORE IN PREDICTING POSTOPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING LAPAROTOMY – A PROSPECTIVE STUDY " - NO. (II) 21032016.**

The following members of Ethics Committee were present in the meeting hold on **22.03.2016** conducted at Madras Medical College, Chennai 3

1.Dr.C.Rajendran, MD.,	:Chairperson
2.Dr.R.Vimala,MD.,Dean,MMC,Ch-3	:Deputy Chairperson
3.Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3	: Member Secretary
4.Prof.P.Raghumani,MS, Dept.of Surgery,RGGGH,Ch-3	: Member
5.Dr.Baby Vasumathi, Director, Inst. of O&G,Ch-8	: Member
6.Prof.M.Saraswathi,MD.,Director, Inst.of Path,MMC,Ch-3	: Member
7.Prof.Srinivasagalu,Director,Inst.of Int.Med.,MMC,Ch-3	: Member
8.Tmt.J.Rajalakshmi, JAO,MMC, Ch-3	: Lay Person
9.Thiru S.Govindasamy, BA.,BL,High Court,Chennai	: Lawyer
10.Tmt.Arnold Saulina, MA.,MSW.,	:Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

MADRAS MEDICAL COLLEGE 31 MAR 2016

Member Secretary – Ethics Committee

MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE
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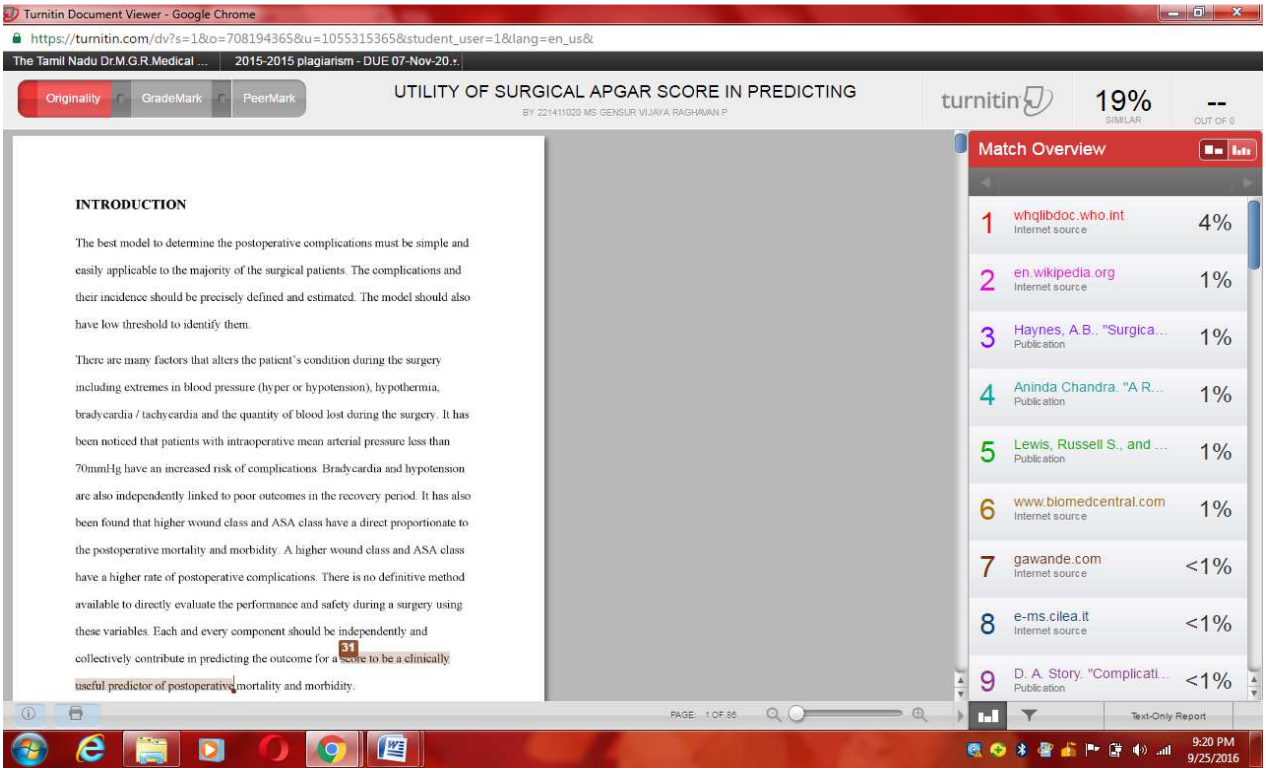
APPENDIX II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INTRODUCTION
The best model to determine the postoperative complications must be simple and easily applicable to the majority of the surgical patients. The complications and their incidence should be precisely defined and estimated. The model should also have low threshold to identify them.
There are many factors that alters the patient's condition during the surgery including extremes in blood pressure (hyper or hypotension), hypothermia, bradycardia / tachycardia and the quantity of blood lost during the surgery. It has been noticed that patients with intraoperative mean arterial pressure less than 70mmHg have an increased risk of complications. Bradycardia and hypotension are also independently linked to poor outcomes in the recovery period. It has also been found that higher wound class and ASA class have a direct proportionate to the postoperative mortality and morbidity. A higher wound class and ASA class have a higher rate of postoperative complications. There is no definitive method available to directly evaluate the performance and safety during a surgery using these variables. Each and every component should be independently and collectively contribute in predicting the outcome for a score to be a clinically useful predictor of postoperative mortality and morbidity.
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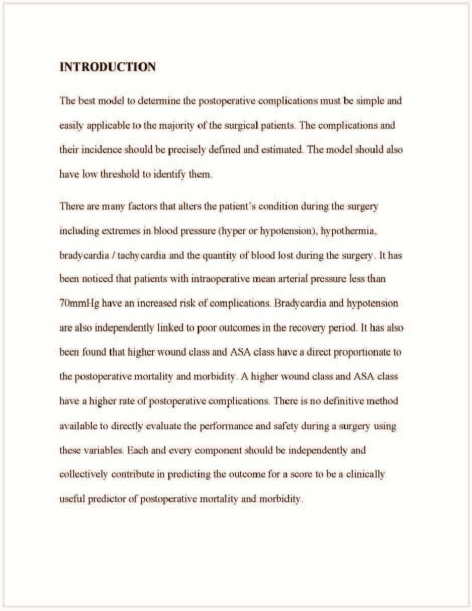

INTRODUCTION

The best model to determine the postoperative complications must be simple and easily applicable to the majority of the surgical patients. The complications and their incidence should be precisely defined and estimated. The model should also have low threshold to identify them.

There are many factors that alters the patient's condition during the surgery including extremes in blood pressure (hyper or hypotension), hypothermia, bradycardia / tachycardia and the quantity of blood lost during the surgery. It has been noticed that patients with intraoperative mean arterial pressure less than 70mmHg have an increased risk of complications. Bradycardia and hypotension are also independently linked to poor outcomes in the recovery period. It has also been found that higher wound class and ASA class have a direct proportionate to the postoperative mortality and morbidity. A higher wound class and ASA class have a higher rate of postoperative complications. There is no definitive method available to directly evaluate the performance and safety during a surgery using these variables. Each and every component should be independently and collectively contribute in predicting the outcome for a score to be a clinically useful predictor of postoperative mortality and morbidity.

APPENDIX III

INFORMATION SHEET

TITLE: "UTILITY OF SURGICAL APGAR SCORE IN PREDICTING POSTOPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING LAPAROTOMY – A PROSPECTIVE STUDY"

Name of Investigator: Dr.P.Vijaya Raghavan

Name of Participant:

Purpose of Research : To evaluate the efficacy of a scoring system using the intraoperative blood loss, lowest mean arterial pressure and lowest pulse rate.

S**tudy Design :** Prospective Observational Study

Study Procedures : Patient will be subjected to routine investigations like complete blood count and renal function test to findout the preoperative status of the patient.

Possible Risks : No risks to the patient

Possible benefits:

To patient : Patients treatment is tailored to their specific risk predictions.

To doctor & to other people : If this study gives positive results, it can help surgeons predict high risk patients who are likely to suffer major complications and death in the post-operative period. This knowledge of high risk patients can help in their careful surveillance postoperatively so that necessary precautions can be taken to prevent complications and death.

Confidentiality of the information obtained from you : The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared

Can you decide to stop participating in the study : Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time

How will your decision to not participate in the study affect you : Your decision will not result in any loss of benefits to which you are otherwise entitled.

Signature of Investigator — Signature Of Participant

Date : — Date:

Place : — Place:

PATIENT CONSENT FORM

Study Detail : "UTILITY OF SURGICAL APGAR SCORE IN PREDICTING POSTOPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING LAPAROTOMY – A PROSPECTIVE STUDY"

Study Centre : Rajiv Gandhi Government General Hospital, Chennai.

Patient's Name :

Patient's Age :

Id Number :

Patient may check (√) these boxes

a) I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ❑

b) I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ❑

c) I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ❑

d) I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ❑

e) I hereby consent to participate in this study. ❑

f) I hereby give permission to undergo detailed clinical examination and blood investigations as required.

Signature/thumb impression

Patient's Name and Address:

Signature of Investigator

Study Investigator's Name:

Dr.P.VIJAYA RAGHAVAN

APPENDIX IV – SAMPLE QUESTIONNAIRE

UTILITY OF SURGICAL APGAR SCORE IN PREDICTING POSTOPERATIVE MORBIDITY AND MORTALITY IN PATIENTS UNDERGOING LAPAROTOMY – A PROSPECTIVE STUDY

PATIENT NO. DATE:

A.INPATIENT FILE NUMBER B.MOBILE NUMBER

C.NAME D.AGE (IN YEARS)

E.SEX: MALE FEMALE

F.NATURE OF PROCEDURE EMERGENCY ELECTIVE

G.INTRA-OPERATIVE DIAGNOSIS

H.DURATION OF OPERATION (MINUTES)

I.SURGICAL APGAR SCORE:

PARAMETER	RECORDED	SCORE
ESTIMATED BLOOD LOSS(ml)		
LOWEST MEAN ARTERIAL PRESSURE(mmHg)		
LOWEST PULSE RATE(beats/min)		

TOTAL SCORE (SAS)

J.MAJOR COMPLICATIONS (source Copeland et al)

ABSENT ☐

PRESENT ☐ SPECIFY TYPE:

1. HAEMORHAGE –SUPERFICIAL ☐
   -DEEP ☐
2. INFECTION -SUPERFICIAL, WOUND ☐
   -DEEP, WOUND ☐
   -URINARY ☐
   -RESPIRATORY ☐
   -SEPTICAEMIA ☐
3. PYREXIA OF UNKNOWN ORIGIN ☐
4. WOUND DEHISCENCE ☐
5. ANASTOMOTIC LEAKAGE ☐
6. THROMBOSIS
   -DEEP VENOUS ☐
   -PULMONARY EMBOLISM ☐
7. ORGAN DYSFUCTION
   - RENAL ☐
   -CARDIAC ☐
   -RESPIRATORY ☐
8. HYPOTENSION ☐
9. DEATH ☐
10. OTHERS: ☐

APPENDIX V – STATISTICAL FORMULA

B. Arrithmatic mean, $X = \frac{\sum fx}{N}$ (for grouped data)

C. Standard deviation , $SD = \sqrt{\frac{\sum (X - \bar{X})^2}{}}$

('O' indicates observed value and 'E' indicates expected value)

D. $$Z = \frac{P_1 - P_2}{\sqrt{\left[\frac{P_1 Q_1}{N_1} + \frac{P_2 Q_2}{N_2}\right]}}$$

P_1 indicates proportion in first group

P_2 indicates proportion in second group

$Q_1 = 100 - P_1$

$Q_2 = 100 - P_2$

N_1 indicates sample size of first group

N_2 indicates sample size of second group.

E. $$SD = \sqrt{\frac{\sum (X - \bar{X})}{(N-1)}}$$

Here, $\bar{X}$ indicates mean value

X indicates individual value

N indicates sample

MASTER CHART

APPENDIX VI – MASTER CHART

NAME	AGE	SEX	DIAGNOSIS	EL/EM	DURA	YES/NO	COMP	L HR	L MAP	EBL	SAS	RISK
AARATHI	40	F	OBS HERNIA	M	70	N	-	82	72	75	7	MR
AATHI	44	F	OBS HERNIA	M	65	N	-	73	68	325	6	MR
ABJA	23	F	PI	M	130	Y	AL	66	62	750	5	MR
AJITHA	21	F	IA	M	60	N	-	55	69	80	9	LR
AMIRTHA	24	F	PI	M	125	Y	DWI	73	63	330	6	MR
ANANDI	29	F	PERI	M	90	Y	SWI	75	72	50	7	MR
ANANYA	26	F	PI	M	95	Y	AL	75	45	700	4	HR
ANBU	25	F	PI	M	125	N	-	58	71	75	9	LR
ANGALAMMAL	53	F	cholecystitis	M	125	N	-	74	62	270	6	MR
ANOOPA	19	F	PERF	M	125	Y	DWI	69	63	75	7	MR
ARAVIND	---------- LOST DURING FOLLOW UP----------											
ARUNA	27	F	PI	M	100	N	-	72	62	425	6	MR
ASHA	26	F	PI	M	140	Y	D	81	62	125	5	MR
BAKKIYA	26	F	PI	M	125	Y	AL	100	37	750	1	HR
BALA	21	F	PERF	M	80	Y	DWI	79	61	180	5	MR
BALAMMA	24	F	PI	M	85	N	-	66	66	260	6	MR
BASHA	18	F	PI	M	135	Y	WD	66	69	250	6	MR
BHAKTHA	38	F	PERI	M	135	Y	SWI	90	53	300	3	HR
BHARATHI	32	F	PERI	M	110	Y	SWI	92	39	150	2	HR
BHUVANESHWARI	43	F	IA	M	125	Y	D	82	72	85	7	MR
CHELLA	80	F	cholecystitis	M	70	N	-	98	35	900	1	HR
DHANALAKSHMI	54	F	PERI	M	110	N	-	110	35	750	1	HR
DHANAM	32	F	PERI	M	140	Y	RD	73	72	80	8	LR
DILLI	34	F	PERI	M	140	Y	DWI	87	37	350	2	HR

DILSATH	29	F	OTB ABDOMEN	L	125	N	-	95	35	750	1	HR
EESHA	18	F	IA	M	90	Y	SWI	68	58	330	6	MR
ELATHA	32	F	PERI	M	145	Y	D	83	68	225	5	MR
ESHWARI	23	F	PERF	M	105	Y	AL	82	58	150	5	MR
FAROOQ	28	M	OLIVER ABSCESS	L	60	N	-	90	38	650	3	HR
GANDHIMATHI	66	F	IA	M	85	Y	RD	60	72	50	9	LR
GANGA	39	F	IO	M	145	Y	RD	80	61	150	5	MR
GOVINDAMMAL	44	F	IA	M	65	Y	DWI	110	37	800	1	HR
GUNASEKARI	33	F	PERI	M	105	Y	DWI	68	61	270	6	MR
HARSHAVADHANI	49	F	OCDD	L	140	N	-	79	57	60	5	MR
INDRA	27	F	IO	M	125	Y	D	70	63	625	5	MR
JANAKI	28	F	OSPLENIC INFARCT	L	95	N	-	70	68	375	6	MR
JAYAPAL	39	M	IA	M	90	Y	WD	73	49	700	4	HR
JOTHI	26	M	PI	M	85	Y	AL	72	51	650	4	HR
JOTHIKUMARAN	19	M	IO	M	95	Y	AL	67	59	250	6	MR
KALAIARASAN	26	M	PI	M	105	N	-	68	58	350	6	MR
KALEESWARAN	57	M	IA	M	80	N	-	82	41	600	3	HR
KALYAN	50	M	PI	M	95	N	-	82	36	500	2	HR
KAMAL	62	M	IO	M	130	Y	D	82	38	700	1	HR
KARTHIK	14	M	PI	M	95	N	-	82	68	375	6	MR
KARUBAKARAN	50	M	IA	M	60	N	-	82	51	750	3	HR
KARUNA	67	M	PERF	M	125	Y	AL	82	35	650	1	HR
KARUPPAN	19	M	BI	M	120	Y	DWI	82	61	650	5	MR
KAVATI	26	M	BI	M	135	N	-	82	73	150	8	LR
KAZHANJI	22	M	PERF	M	80	N	-	82	55	55	7	MR
KISHORE	14	M	PI	M	105	N	-	82	71	500	8	LR
KRISHNAMOORTHY	74	M	IA	M	95	Y	WD	82	51	650	4	HR
KRISHNAN	27	M	PERI	M	105	N	-	82	61	225	6	MR
KULSAR	23	M	PERF	M	65	Y	SWI	82	58	350	6	MR

KUMAR	24	M	IO	M	125	Y	DWI	82	36	650	1	HR
KUMARESAN	33	M	PERF	M	130	Y	AL	82	38	200	2	HR
KUPPAN	41	M	OBS HERNIA	M	60	N	-	82	62	200	6	MR
LAKSHMAN	21	M	BI	M	95	N	-	82	69	400	7	MR
LAKSHMANAN	37	M	IO	M	105	N	-	82	62	125	5	MR
LALITHKUMAR	24	M	BI	M	100	N	-	82	69	350	6	MR
LALITHRAJ	35	M	IA	M	65	N	-	82	56	150	5	MR
LOGESH	29	M	PERI	M	130	Y	WD	82	38	650	1	HR
MABUBAN	75	M	OBS HERNIA	M	75	N	-	82	38	150	2	HR
MAHESHWARAN	29	M	PERI	M	115	Y	SWI	82	71	65	7	MR
MANGAN	24	M	ODIAPHRAGMATIC HERNIA	M	150	Y	RI	82	38	200	2	HR
MARI	40	M	IO	M	100	N	-	82	65	55	7	MR
MARIYAPPPAN	15	M	IO	M	105	Y	SWI	82	59	290	6	MR
MARJITH	17	M	PI	M	95	N	-	82	71	80	9	LR
MAYA	39	F	IO	M	115	N	-	82	58	300	5	MR
MAYA	24	F	PI	M	115	N	-	82	64	425	6	MR
MAYA KRISHNAN	14	M	PERF	M	70	Y	AL	82	55	150	6	MR
MAYANDI	37	M	PERI	M	125	Y	DWI	82	39	150	2	HR
MEIYAPPAN	68	M	MESENTRIC ISCHEAMIA	M	150	Y	D	82	36	650	1	HR
MOHAN	54	M	IA	M	130	Y	D	82	59	650	5	MR
MOHANAKUMARAN	26	M	PERF	M	70	N	-	82	73	50	9	LR
MUKESH	27	M	PI	M	135	Y	AL	82	51	1100	2	HR
MUKUNTH	32	M	PERI	M	115	N	-	82	61	150	5	MR
MURALI	25	M	PI	M	100	N	-	82	58	330	6	MR
MURUGESAN	27	M	PERI	M	135	N	-	82	62	125	5	MR
MUTHU	30	M	IA	M	100	Y	DWI	82	58	300	5	MR
NARAYANAMOORTHY	27	M	PI	M	85	N	-	82	69	170	6	MR
NATARAJ	51	M	IO	M	85	N	-	82	43	650	3	HR

NIKHIL	24	M	PI	M	110	N	-	82	59	225	6	MR
NIRMAL	43	M	OINTERLOOP ABSCESS	L	70	N	-	82	35	600	1	HR
PADMANADHAN	40	M	IA	M	75	N	-	82	62	80	7	MR
PALANI	48	M	BI	M	85	N	-	82	65	700	4	HR
PALANI	76	M	MESENTRIC ISCHEAMIA	M	145	Y	RD	82	62	125	5	MR
PALAPANDI	25	M	PI	M	110	N	-	82	62	275	6	MR
PANDIAN	26	M	PERF	M	60	N	-	82	66	60	7	MR
PERIYASAMY	52	M	IA	M	75	Y	DWI	82	38	850	1	HR
PONNIYIN SELVAN	47	M	IO	M	115	N	-	82	59	250	5	MR
POOCHENDU	26	F	OTB ABDOMEN	L	135	Y	WD	82	67	325	6	MR
RADHAKRISHNAN	54	M	PERI	M	90	N	-	82	62	55	7	MR
RAGOTHAMAN	25	M	PERF	M	130	Y	DWI	82	38	700	1	HR
RAHMATH	48	M	IO	M	100	N	-	82	61	150	5	MR
RAJESH	46	M	IO	M	120	Y	AL	82	37	250	2	HR
RAJESH	30	M	PERI	M	125	Y	SWI	82	52	250	3	HR
RAJESHWARAN	33	M	PERI	M	140	Y	WD	82	36	700	1	HR
RAJESHWARI	49	M	IO	M	125	N	-	82	62	175	5	MR
RAJINI	19	M	PI	M	130	N	-	82	59	650	5	MR
RAKESH	27	M	PI	M	130	N	-	82	63	800	5	MR
RAKKI	28	M	PI	M	130	Y	D	82	61	150	5	MR
RAM	29	M	PI	M	90	Y	SWI	82	48	650	4	HR
RAM	42	M	IO	M	80	N	-	82	65	75	7	MR
RAMKUMAR	22	M	BI	M	80	N	-	82	73	500	7	MR
RANJITH	29	M	PERI	M	100	N	-	82	58	350	6	MR
RAVI	57	M	OPERINEPHRIC ABSCESS	M	105	N	-	82	37	350	2	HR
REET	35	M	IO	M	85	N	-	82	55	55	7	MR

REKHARAJAN	35	M	PERF	M	95	Y	SWI	82	51	350	3	HR
RENGARAJ	23	M	BI	M	85	N	-	82	75	250	9	LR
RISHI	53	M	BI	M	80	N	-	82	62	800	4	HR
RITHISH	22	M	BI	M	95	N	-	82	75	180	9	LR
SAKHIR	28	M	PI	M	105	Y	DWI	82	66	220	6	MR
SANDHANAM	42	M	OLIVER ABSCESS	M	75	N	-	82	65	225	6	MR
SANJEEV	53	M	OINTERLOOP ABSCESS	M	80	N	-	82	59	125	5	MR
SANKARAN	18	M	BI	M	100	N	-	82	68	550	6	MR
SARASWATHI	38	F	OTRIPLE BYPASS	L	165	Y	D	82	37	700	1	HR
SARAVANAN	31	M	PERI	M	95	N	-	82	72	85	5	MR
SARAVANAVEL	42	M	IO	M	145	N	-	82	66	275	5	MR
SATHISH	15	M	PI	M	120	N	-	82	66	375	6	MR
SATHYA	22	M	PERF	M	80	N	-	82	68	90	7	MR
SATHYAPRIYAN	28	M	BI	M	105	N	-	82	65	750	5	MR

SEENU RAJ	34	M	IO	M	90	N	-	82	68	90	7	MR
SELVAN	37	M	PERF	M	135	Y	D	82	66	175	6	MR
SELVAVIGNESH	45	M	PI	M	90	N	-	82	65	225	6	MR
SENDOORAMANI	24	M	BI	M	90	N	-	82	75	275	9	LR
SHANKAR	14	M	IO	M	115	Y	WD	82	63	275	6	MR
SHANMUGAM	73	M	Cholecystitis	M	90	N	-	82	35	1100	1	HR
SHENBAGARAJ	32	M	PERI	M	105	N	-	82	62	275	6	MR
SIDDHARTHAN	26	M	PERI	M	140	N	-	82	58	300	5	MR
SINGARAVELAN	20	M	PERF	M	65	N	-	82	76	75	9	LR
SIRAJUDEEN	57	M	IO	M	90	N	-	82	53	800	3	HR
SUBBIAH	28	M	PERF	M	90	Y	AL	82	51	150	3	HR
SUDHAKAR	25	M	PI	M	125	N	-	82	58	750	5	MR
SUKUMAR	32	M	PERI	M	145	Y	D	82	59	125	5	MR
SULAIMAN	56	M	IO	M	80	N	-	82	66	60	7	MR
SUMAN	28	M	BI	M	135	Y	SWI	82	58	300	5	MR
SURESH	27	M	PERF	M	95	N	-	82	65	85	7	MR
TAMILSELVAN	36	M	PERI	M	120	Y	DWI	82	69	320	6	MR
UMAIAPPAN	48	M	ODIAPHRAGMATIC HERNIA	L	135	N	-	82	38	700	1	HR
UMESH	38	M	OWHIPPLE	L	195	Y	D	82	35	850	1	HR
VARUN	26	M	HYDATID CYST	L	150	N	-	82	45	250	4	HR
VENKATESAN	33	M	OFREYS PROCEDURE	L	160	N	-	82	35	600	1	HR
VETTAIYAN	16	M	BI	M	90	N	-	82	71	450	7	MR
VICTOR	23	M	BI	L	120	N	-	82	61	250	6	MR
VIJAY	51	M	OCOLOSTOMY REVERSAL	L	100	N	-	82	68	225	6	MR

VIMAL	43	M	IO	L	95	N	-	82	67	75	7	MR
VINAY	56	M	OCOLOSTOMY REVERSAL	L	90	N	-	82	35	150	2	HR
VINOTH	46	M	OSPLENIC INFARCT	L	100	N	-	82	62	425	6	MR
VISAL	57	M	OPARTIAL GASTRECTOMY	L	130	N	-	82	36	700	1	HR
VISWA	23	M	PI	M	105	N	-	82	59	290	6	MR
YASHWANTH	28	M	BI	L	130	Y	WD	82	58	125	6	MR
YOGESH	22	M	PERF	L	75	N	-	82	72	75	9	LR
YUVARAJ	32	M	IO	L	95	N	-	82	75	50	9	LR
YAGAPPARAJ	LOST DURING FOLLOW UP											

APPENDIX VII – KEY TO MASTER CHART

SEX : M – MALE F – FEMALE

DIAGNOSIS: OBS HERNIA – OBSTRUCTED HERNIA

PI – PENETRATING INJURY

IA – INTRA-ABDOMINAL ABSCESS

PERI – PERITONITIS

PERF – PERFORATION

BI – BLUNT INJURY

CDD – CHOLEDOCHODEUODENOSTOMY

EL/EM : L – ELECTIVE M – EMERGENCY

YES/NO : Y – COMPLICATIONS PRESENT N – COMPLICATIONS ABSENT

COMPLICATIONS: AL – ANASTAMOTIC LEAKAGE

RI – RESPIRATORY INFECTION

D – DEATH

SWI – SUPERFICIAL WOUND INFECTION

DWI – DEEP WOUND INFECTION

WD – WOUND DEHISCENCE

RD – RENAL DYSFUNCTION

L HR: LOWEST HEART RATE

L MAP : LOWEST MEAN ARTERIAL PRESSURE (ROUNDED OFF TO NEAREST WHOLE NUMBER)

EBL : ESTIMATED BLOOD LOSS

SAS : SURGICAL APGAR SCORE

MR – MODERATE RISK

LR – LOW RISK HR – HIGH RISK